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SUBPOTABLE WATER REUSE AT ARMY FIXED INSTALLATIONS: A SYSTEMS A--ETC(U)

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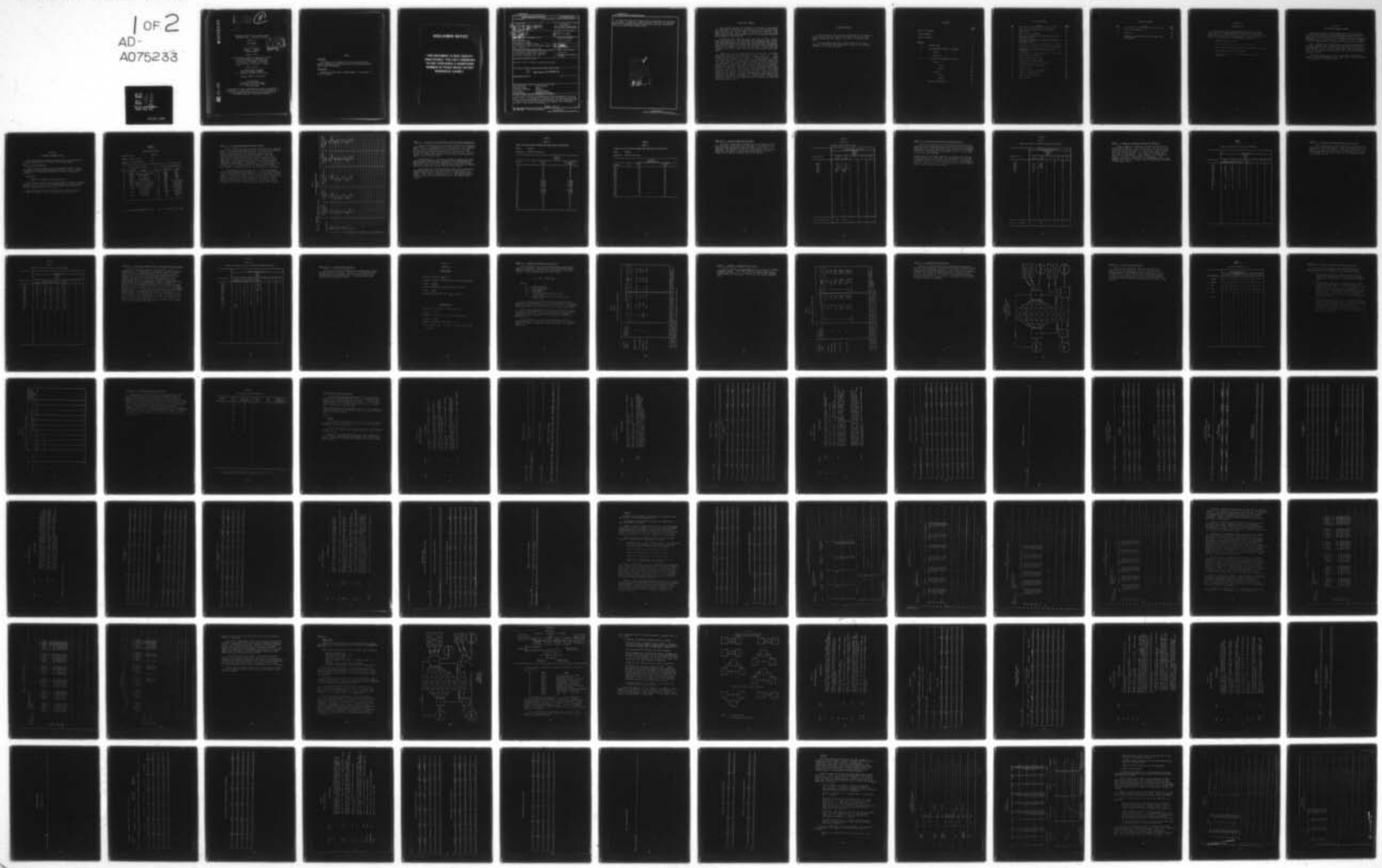

LEVEL III

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SUBPOTABLE WATER REUSE AT ARMY FIXED INSTALLATIONS: A SYSTEMS APPROACH

VOLUME II

USER MANUAL

by
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August 1979

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U.S. Army Medical Bioengineering
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This report concerns the treatment and reuse of wastewater at fixed Army installations. The objective was to provide a tool that could be used by the Army in assessing the potential for water reuse at all their fixed facilities; in isolating those bases with the best reuse potential; and in evaluation conceptual reuse schemes at those bases. Cont'

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All major Army activities involving water and wastewater were researched and described. In addition, a three-tiered water reuse model was developed that leads the evaluates through three phases of evaluation culminating in the use of a sophisticated computer model.

EXECUTIVE SUMMARY

This report concerns the treatment and reuse of wastewater at fixed Army installations. The objective was to provide a tool that could be used by the Army in assessing the potential for water reuse at all their fixed facilities; in isolating those posts with the best reuse potential; and in evaluating conceptual reuse schemes at those posts.

To achieve this objective, two paths were pursued. First, major Army activities involving water and wastewater were identified and described as to: water use and wastewater characteristics, tolerable water quality if reclaimed water were to be used, potential as a donor or recipient of reclaimed water, and the potential for internal reuse at the activity. These data are essential and form a basis for constructing feasible reuse networks.

Secondly, a water reuse evaluation model was developed. This model involves three phases or tiers. Tier I is a comprehensive questionnaire that allows a concise overall evaluation of the reuse potential of a post in a short amount of time. Posts that score well on Tier I may then be evaluated under Tier II. This tier leads the evaluator through a deeper analysis of reuse possibilities on the post, and ends with a brief economic analysis of the fundamental reuse schemes selected for the post. Should this analysis show reuse to be economically beneficial, Tier III is applied. Tier III is a detailed survey that should be used only at posts with proven reuse potential. Field data from activity records and sampling, as well as conceptual reuse networks, are used as input to a mathematical model that determines piping, pumping, storage, and treatment requirements, and costs for the entire reuse system. At this point, the Army post should be ready for full-scale engineering design of the most effective reuse system.

ACKNOWLEDGEMENTS

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This User Manual has been slightly modified from the present contract with the Army Medical Research & Development Command, Ft. Detrick, Maryland.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION I

INTRODUCTION

The cascade water reuse computer program has been developed to aid base engineers in designing wastewater reuse systems. The program requires various input data and human decision-making to be effective. The purpose of this manual is to explain in a comprehensive manner:

- How the program works
- What quantitative input data is required
- Specifically how the data must be prepared for input
- What output can be anticipated
- What decisions will have to be made by base personnel

SECTION II

THE COMPUTER PROGRAM IN GENERAL

The program is divided into two separate phases. Phase I (Activity Description) assimilates activity data supplied by the base and prints out several forms for each activity showing flow patterns, effluent quality characteristics after various levels of treatment, the effects of recommended pretreatment units, and cascade potential. Output from Phase I is intended to assist the base engineer in selecting feasible activity cascade networks.

Phase II (Network Feasibility) evaluates the networks selected by base personnel. Output provides a comprehensive network description including the requirements for piping, pumping, storage, and treatment facilities, and finally the total cost of the entire cascade system. Continued modification of the most cost effective cascade networks should lead to an optimum reuse system for the base.

Note that the program can be used to simulate hourly flows throughout a day, or monthly flows throughout a year. The latter is important for bases with large seasonal fluctuations in water use.

SECTION III

THE COMPUTER PROGRAM IN DETAIL

The following sections delineate in complete detail the required input and generated output data for both phases of the cascade program.

Phase I - Activity Description

For all parts of the program, input goes through two stages. Firstly, base personnel complete standard engineering data forms. Secondly, the data is transferred to computer forms from which the data deck can be punched directly.

Base Input

Preparation of Standard Engineering Data Forms

The first task in using the cascade reuse program is to gather all required base data. Forms 0 through XIII, described below and shown on the following pages, are provided for this purpose. Once completed, these forms provide all the information necessary to the program.

Note that there are duplicates for some forms. Select the form that corresponds to the daily or yearly program, whichever is being used.

SAMPLE
FORM 0

BASE DESCRIPTION

Name of Base: March

Number of Activities: 12

Number of Constituents: 15

List of Activities			List of Constituents		
No.	Code(1)	Name	No.	Code(2)	Name
1	A/AWR	Aircraft Wash Rack	1	BOD	BOD
2	HOUSE	Base Housing	2	COD	COD
3	BOQ	BOQ	3	PHNL	Phenol
4	OFF	Office/Admin.	4	SS	SS
5	PHOTO	Photo Shop	5	TDS	TDS
6	AHH	Arnold Hts. Housing	6	O&G	Oil & Grease
7	GENIR	General Irrigation	7	Cl	Chloride
8	VWR	Vehicle Wash Rack	8	NO_3	Nitrate
9	OFFIR	Office Irrigation	9	NH_4	Ammonium
10	GOLF	Golf Course Irrigation	10	PO_4	Phosphate
			11	Na	Sodium
11	AHIRR	Arnold Hts. Irrigation	12	$CaCO_3$	Hardness
			13	B	Boron
12	HOSP	Hospital	14	CN	Cyanide
			15	Fe	Iron

(1) Five letters/numbers or less (2) Five symbols or less

FORM I - Activity Water/Wastewater Summary

Form I summarizes activity water and wastewater quality data: existing source water quality, tolerable source water quality, and existing final effluent concentrations. Typical concentrations for tolerable source water and effluent discharge are provided in Section II of the main report. These values can be substituted for actual base data if the latter is non-existent. However, it is important to note that the success of the entire program depends on the accuracy of the data. If the tolerable value of a constituent is not significant for that activity, a minus one (-1) can be entered for that concentration. This states in essence that any concentration is tolerable.

The sample Form I provided shows a water/wastewater summary for photographic processing. In this case, base data for tolerable source water quality was not available so the "typical" values provided on the form were used. Both source water quality, which is quite high, and a moderate final waste discharge with a BOD of 200 mg/l are shown. Base data was available for final effluent quality for all constituents so it was not necessary to use "typical" values.

FORM I

ACTIVITY WATER/WASTEWATER
SUMMARY

BASE: SAMPLE
ACTIVITY: Photographic Processing

Constituent	Source Water Concentration (mg/l)	Tolerable Concentration (mg/l)	Typical, Tolerable Concentration (mg/l)	Final Effluent Concentration (mg/l)	Typical, Final Effluent Concentra (mg/l)
1. BOD	0	0.1	0.1	200	99
2. COD	0.3	1.0	1.0	395	320.
3. PHNL	0	0.001	0.001	0.001	0.001
4. SS	0	1.0	1.0	30	30
5. TDS	568	700	700	1,700	1,000
6. O&G	0.2	0.2	0.2	3.9	4.0
7. Cl	150	185	185	200	230
8. NO_3	5	20	20	20	9.0
9. NH_4	0	0.1	0.1	19	16
10. PO_4	1.0	3.0	3.0	3.6	9.3
11. Na	80	100	100	150	130
12. $CaCO_3$	300	400	400	300	200
13. B	0.05	0.1	0.1	0.1	2.8
14. CN	0	0.01	0.01	0.5	0.8
15. Fe	0.2	0.3	0.3	0.4	3.8
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
32.					
33.					

FORM II - Activity Water Demand and Wastewater Generation

Form II summarizes activity water demand and wastewater generation flow information on an hourly basis for a typical day. If flow information is not available for all hours of the day, at least one hourly flow should be entered. Be sure to enter zero (0) for hours of inactivity. The program will interpolate whatever hourly data are provided to obtain flows for all hours.

Alternatively, if the yearly program is being used, then water demand and wastewater generation flow information for each month of the year must be provided on the yearly form. Note that flow units are in 1,000-gal per month for the yearly program, and gallons per day for the daily program.

The sample Form II provided shows daily water demand and wastewater generation data for an aircraft wash rack. As shown, there is zero flow until 8:00 a.m. when washing commences. Also there is some water loss in the washing operation, as seen by comparing the "water in" and "water out" columns.

SAMPLE

FORM II

DAILY ACTIVITY WATER DEMAND AND WASTEWATER GENERATION

Base: Sample

Activity: Aircraft Washing

	Volume (gph)	
Hours	Water In	Wastewater Out
0	0	0
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	5,000	4,000
9	5,000	4,000
10	5,000	4,000
11	5,000	4,000
12	0	0
13	5,000	4,000
14	5,000	4,000
15	2,000	1,700
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0

SAMPLE

FORM II

YEARLY ACTIVITY WATER DEMAND AND WASTEWATER GENERATION

Base: Sample

Activity: Aircraft Washing

	Volume (1,000 gal/mo)	
Months	Water In	Wastewater Out
JAN	20	16
FEB	20	16
MAR	22	18
APR	25	20
MAY	27	22
JUN	28	22
JUL	30	24
AUG	30	24
SEP	28	22
OCT	25	20
NOV	20	16
DEC	20	16

FORM III   Source Water Quality/Cost

Form III is provided to summarize source water quality for each major water source on the base. "In addition, the cost of procuring and/or treating these source waters is addended. Two sources are shown in the sample with separate qualities and costs. Sources are designated by both a number and a name of not more than five letters.

SAMPLE

FORM III

SOURCE WATER QUALITY/COST

Constituent	Concentration (mg/l) Sources Name (No.)				
	(1) Wells	(2) Lake	(3)	(4)	(5)
BOD	0.1	0			
COD	0.3	0.2			
SS	0.1	0			
PHNL	0.01	0.01			
TDS	300	600			
NO_3	5	15			
Cost: ¢/1000 gal	50	35			

FORM IV - Effluent Discharge Requirements/Cost

Form IV is to be used for delineating required final discharge concentrations for each major point of discharge from the base. Costs assessed to this discharge (excluding treatment), such as sewer surcharges, are also to be shown. The sample form shows two discharges, one to a river, one to the city sewer system.

Minue ones (-1) indicate infinity, or in essence, that no limit is required. Note also the difference in costs for discharge; the river discharge being free of charge while the flow going to the city is surcharged at a 30¢/1,000 gal average. Discharges are designated by both a number and a name of not more than five letters.

SAMPLE

FORM IV

FINAL EFFLUENT DISCHARGE REQUIREMENTS/COST

Constituent	Concentration (mg/l) Discharges Name (No.)				
	(1) River	(2) City	(3)	(4)	(5)
BOD	20	300			
COD	50	500			
SS	20	300			
PHNL	1.0	-1			
TDS	-1	-1			
NO_3	30	-1			
Cost: ¢/1000 gal	0	30			

FORM V – Special Treatment Removal Percentages

Form V summarizes removals achieved by the special pretreatment modules. Each constituent must be assigned a removal percentage, even if it is zero. Special treatments are designated by both a number and a code name of 10 letter maximum length. The sample form designates four special treatments: metal removal, oil and grease removal, softening, and chemical coagulation. The engineer is free to choose his own pretreatment units and removal efficiencies. He may also use those four provided in the sample form.

SAMPLE

FORM V

SPECIAL TREATMENT REMOVAL PERCENTAGES

Constituent	Removal % Chain Name (No.)						
	(1) Metal Removal	(2) Oil & Grease	(3) Soften-ing	(4) Chem. Coag.	(5)	(6)	(7)
BOD	20	25	0	50			
COD	20	30	0	50			
PHNL	20	60	0	70			
SS	20	20	0	30			
TDS	0	0	0	0			
O&G	20	75	0	20			
Cl	0	0	0	0			
NO_3	0	0	0	0			
NH_4	0	0	0	0			
PO_4	0	0	0	85			
Na	0	0	0	0			
$CaCO_3$	0	0	98	0			
B	85	10	0	0			
CN	85	10	0	0			
Fe	85	10	0	0			

FORM VI - Regular Treatment Removal Percentages

Form VI provides the same information as Form V for the regular treatment chains. Note that removals are for the entire chain, not specific units within the chain. Again, base personnel are free to choose their own chains and removal efficiencies or they can use those provided in the sample form.

SAMPLE

FORM VI

REGULAR TREATMENT REMOVAL PERCENTAGES

Constituent	Removal % Chain Name (No.)						
	(1) Primary	(2) Secondary	(3) Filtration	(4) Carbon Ads.	(5) Rev. Osmos.	(6)	(7)
BOD	30	85	94	99	100		
COD	30	80	88	96	99		
PHNL	30	75	75	92	92		
SS	70	85	98	100	100		
TDS	0	0	20	20	91		
O&G	50	75	85	96	97		
Cl	0	0	0	0	80		
NO_3	0	0	0	20	70		
NH_4	0	95	95	100	100		
PO_4	0	20	85	85	98		
Na	0	0	0	0	75		
$CaCO_3$	0	0	0	0	90		
B	10	80	80	80	96		
CN	10	80	80	80	96		
Fe	10	60	60	60	96		

FORM VII Special Treatment Chain Threshold Concentrations

Form VII provides data utilized in Phase I of the program only. For each special treatment, threshold concentrations for all constituents must be provided. In each case, an activity will be assigned the appropriate pretreatment if any of its raw wastewater concentrations are higher than one of the threshold concentrations. For example, assume an oil and grease threshold of 500 mg/l is assigned for the oil-and-grease-removal treatment module. Then for any activity generating a waste in excess of 500 mg/l oil and grease, the computer will not only provide the typical Phase I summary for that activity but will also provide a similar summary assuming grease and oil pretreatment at the activity. In this way, base personnel can review the Phase I output to determine the benefits of activity pretreatment. Note that for constituents that are not applicable to certain pretreatments, i.e., TDS in grease and oil removal, a minus one should be entered, which basically sets the threshold concentrations at infinity. Base personnel are free to use the values provided on the sample form or ones of their own choosing.

SAMPLE

FORM VII

SPECIAL TREATMENT CHAIN THRESHOLD CONCENTRATIONS

Constituent	Concentration (mg/l)						
	Chain Name (No.)						
	(1) Metal Removal	(2) Oil & Grease	(3) Soften-ing	(4) Chem. Coag.	(5)	(6)	(7)
BOD	-1	-1	-1	1,000			
COD	-1	-1	-1	2,000			
PHNL	-1	-1	-1	-1			
SS	-1	-1	-1	1,000			
TDS	-1	-1	-1	-1			
O&G	-1	200	-1	-1			
Cl	-1	-1	-1	-1			
NO_3	-1	-1	-1	-1			
NH_4	-1	-1	-1	-1			
PO_4	-1	-1	-1	100			
Na	-1	-1	-1	-1			
$CaCO_3$	-1	-1	500	-1			
B	100	-1	-1	-1			
CN	0.5	-1	-1	-1			
Fe	100	-1	-1	-1			

FORM VIII Cost Data/Piping Data

Form VIII provides necessary cost factors and indices as well as data on piping. The form is self-explanatory. Values shown in the sample form were those used by SCS Engineers during program testing. Naturally, the cost indices will change with time.

SAMPLE

FORM VIII

COST DATA

. Rate of interest: 10 %

. Current Engineering News Record Construction Cost Index: 2,103

. Current Engineering News Record Labor Cost Index: 4.71

. Estimated Equipment Life: 25 years

PIPING DATA

. Maximum flow velocity in pressure pipes: 5 ft/sec

. Maximum flow velocity in gravity flow pipes: 5 ft/sec

. Number of possible pipe sizes: 12

. List of pipe sizes: 1, 2, 3, 4, 6, 8, 10, 12, 15, 18, 24, 36

FORM IX - Special Treatment Chain Costs

Form IX summarizes the cost coefficients used to cost special treatments. Capital and O & M cost coefficients are taken from the cost equations delineated in the main report. These equations are all of the form:

$$S = (A + BQ^c) \frac{I}{I^1}$$

Where:

- A = fixed cost (\$)
- B = unit cost (\$/gpd)
- c = scale factor
- Q = flow (gpd)
- I = current Engineering News Record cost index
- I^1 = January 1975 Engineering News Record cost index

It is imperative that all cost coefficients used as input data be represented as January 1975 dollars. The program will automatically update all costs for years following 1975 according to the current indices previously supplied.

Again, base personnel are free to use the coefficients provided on the sample form, or to generate their own cost curves and equations. Care must be taken to represent equations in the standard $A + BQ^c$ form and to update to 1975 dollars.

It is important to note that the coefficients for each component of a multi-unit treatment chain (i.e., metal removal followed by chemical coagulation) must be listed separately.

SAMPLE

FORM IX

SPECIAL TREATMENT CHAIN COSTS

Treatment Chain Name	No. of Components* in Chain	Cost Coefficients					
		Capital			O&M		
		A	B	C	A	B	C
Metal Removal	1	0	435	0.41	16.24	57.93	0.41
Oil & Grease	1	0	36.28	0.71	0	0.31	0.82
Softening	1	5,000	0.02	1.0	0	0.36	1.0
Chem. Coag.	1	0	435	0.41	16.24	57.93	0.41

* Be sure to include cost coefficients for each element of the treatment chain For example, if two pretreatment units are combined in one chain, each must have its cost coefficient listed.

* All cost coefficients must be represented in January 1975 $.

FORM X — Regular Treatment Chain Costs

Form X provides the same data as Form IX for all regular treatment chains. Note that component coefficients are listed separately, i.e., the carbon adsorption chain shows coefficients for secondary, filtration, and carbon adsorption.

SAMPLE

FORM X

REGULAR TREATMENT CHAIN COSTS

Treatment Chain Name	No. of Components* in Chain	Cost Coefficients					
		Capital			O&M		
		A	B	C	A	B	C
Primary	1	0	36.28	0.71	0	0.31	0.82
Secondary	1	0	1,159	0.51	0	362.9	0.40
Filtration	2	0	1,159	0.51	0	362.9	0.40
		0	29.97	0.63	0	5.95	0.63
Carbon Ads.	3	0	1,159	0.51	0	362.9	0.40
		0	29.97	0.63	0	5.95	0.63
		0	128.1	0.63	0	2.73	0.72
Rev. Osmosis	4	0	1,159	0.51	0	362.9	0.40
		0	29.97	0.63	0	5.95	0.63
		0	128.1	0.63	0	2.73	0.72
		13,550	0.10	1.0	75.78	0.13	1.0

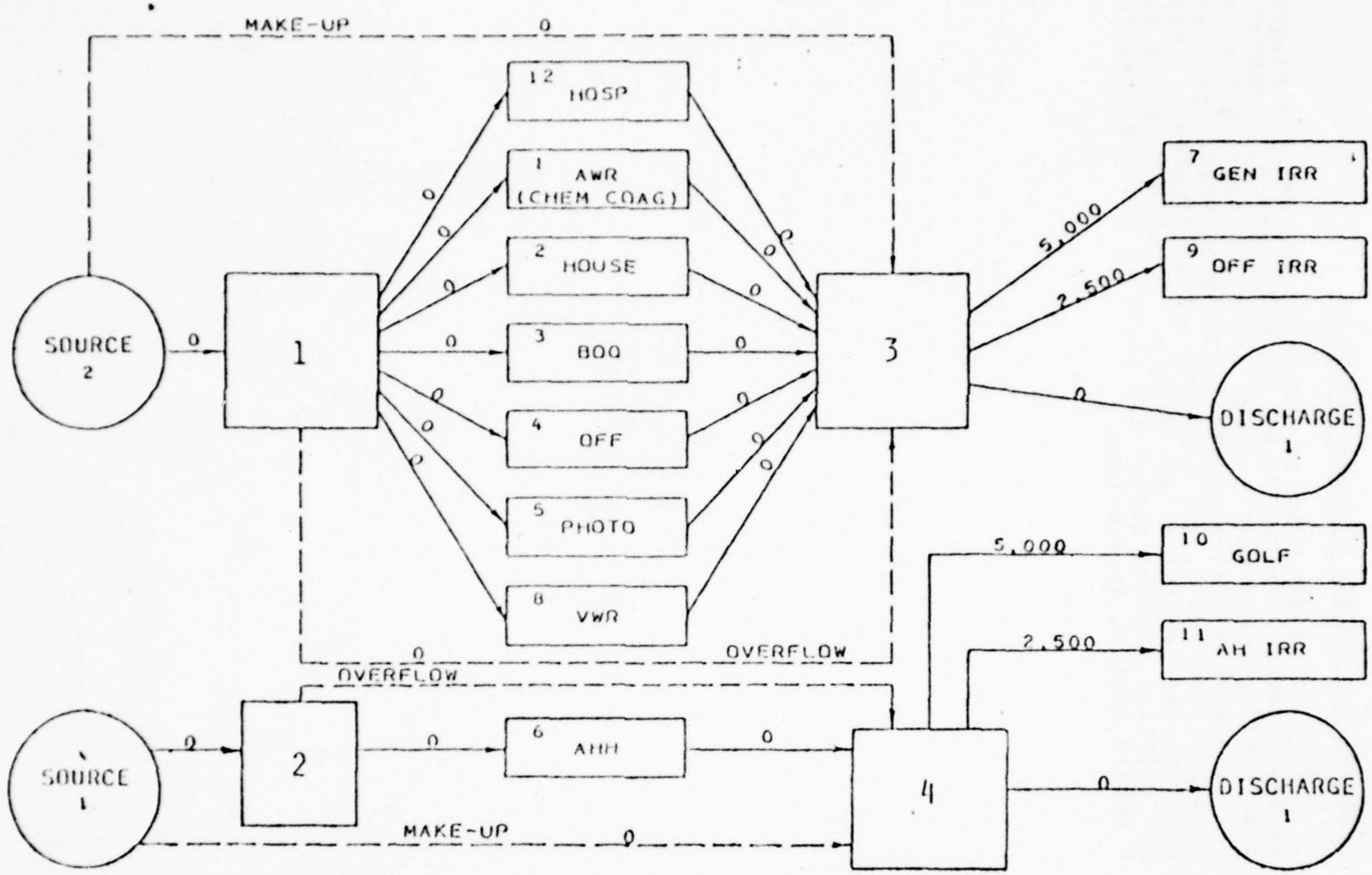
* Be sure to include cost coefficients for each element of the treatment chains. For example, if three units are combined in one chain (i.e., secondary, filtration, and carbon adsorption), each must have its cost coefficient listed.

* All cost coefficients must be represented in January 1975 $.

FORM XI — Cascade Network Diagram

Form XI is provided for each cascade network diagram. As described in Section IV of the main report, "Program Synopsis," this diagram must include all activities, BTS's, specified activity pretreatments (optional), specified treatment at BTS's (optional), all BTS make-up and discharge lines, and also the lengths of all piping. To eliminate the costs for existing piping, assign all existing pipes a zero length. A sample network is provided.

FORM XI
Cascade Network Diagram
Base: March
Network No. 2



FORM XII - Activity Pretreatment

Form XII delineates all activity pretreatments specified by base personnel. For all networks, each activity must be designated either a zero (meaning no pretreatment) or the number of the pretreatment desired. As shown in the sample, the aircraft wash rack (A/AWR) has been assigned chemical coagulation pretreatment,and the photo shop metal-removal pretreatment for some of the networks.

SAMPLE
FORM XII

ACTIVITY PRETREATMENT

	Pretreatment No.									
	Network No.									
Activities	1	2	3	4	5	6	7	8	9	10
1. A/AWR	4	4	4	0	4	0	4	0	4	4
2. HOUSE	0	0	0	0	0	0	0	0	0	0
3. BOQ	0	0	0	0	0	0	0	0	0	0
4. OFF	0	0	0	0	0	0	0	0	0	0
5. PHOTO	0	1	1	0	1	1	1	1	0	0
(etc.)										

FORM XIII Specified Regular Treatment at BTS's

Form XIII is provided so that base personnel may fully delineate any treatment they desire at a BTS. Three options exist in regards to treatment at a BTS:

1. The engineer specifies nothing and allows the program to compute required constituent removal percentages and select the appropriate treatment chain.

2. The engineer specifies a treatment chain. The program then proceeds to compare the removals provided by that chain with those required. If the specified chain can produce a satisfactory effluent in all constituent categories, then that chain is used. If, however, one or more of the contaminants are not satisfactorily removed, the program will assign a more advanced treatment chain to that BTS.

3. The engineer specifies removal percentages for each constituent. Again, the program will compare specified and required removals, select the larger in each case, and choose the appropriate treatment to meet those removals. As shown in the sample form, space is provided for specifying individual constituent removals or whole treatment chain at a BTS.

SAMPLE

FORM XIII

SPECIFIED REGULAR TREATMENT AT BTS'S

Network No.	BTS No.	Specified Removal Percentages Constituents										Specified Regular Treatment Chain No.
		BOD	COD	SS	etc							
2	3											3
4	5	90	90	90								

FORM XIV - BTS Make-Up Water Treatment

Each BTS in a network requires a make-up water line in the event that additional water is needed to meet demand. The option exists of having this make-up water blended and treated with the rest of the influent to the BTS or of having the make-up by-pass treatment and be blended directly with the treated BTS effluent. In most cases, high quality make-up (usually the potable supply) will be used, in which case blending should occur after treatment. However, if poor quality water, from another BTS for example, is used as make-up, it may be advantageous to have it treated at the BTS it is supplying. The sample form shows instances of the latter circumstance. Note that each BTS must be accounted for.

FORM XIV

BTS MAKE-UP WATER TREATMENT

Network No.	BTS No.	Make-Up Treatment(1)	Network No.	BTS No.	Make-Up Treatment(1)
1	1	F			
	2	F			
	3	F			
2	1	F			
	2	T			
	3	F			
	4	T			
3	1	F			
	2	F			
	3	T			
4	1	F			
	2	F			
	3	F			
	4	F			
	5	T			

T - Make-up treated at BTS after blending with influent.
F - Untreated make-up blended with BTS effluent.

Preparation of Computer Forms

The following sections describe the translation of all data from the engineering forms to the computer forms that will be used to punch the data deck. In each case, sample pages are provided for illustration. It is highly unlikely that all lines and pages will be used. Unused lines and pages may be left blank.

Note that throughout the computer form deck, all numbers are right justified in the field and that all words or letter codes are left justified.

Phase I

Input

As previously discussed, Phase I input provides general base data, activity descriptions, source water qualities, discharge requirements, etc.

The following section describes in detail the transferring of this information from the engineering forms to the computer forms.

Remember to use the appropriate forms for the daily or yearly program, whichever is being used. Again, note that flows for the yearly program are expressed in units of 1,000-gal per month.

PHASE I

DATA PRESENTATION

Page	Line	Description
1	1	T in 1st col. if Phase I printout is desired; F if it is not.
		T in 2nd col. if network flow and concentration printout is desired; F if it is not.
		T in 3rd col. if cost summary printout is desired; F if it is not. Be sure to exclude cost data from data deck if F is specified here.
1	2	The name of the base, including blank spaces, in cols. 1-25 (Form 0).
1	3	The total number of constituents (contaminants) to be monitored in the 1st 12 cols. The maximum number of contaminants is 30 (Form 0).
	4, 5	The names of all the constituents in 5 col. blocks (Form 0)

GENERAL BASE DATA

NAME OF BASE

March Air Force Base

NUMBER OF CONTAMINANTS

15

NAMES OF CONTAMINANTS

BOD COD PHNL SS TDS O&G Cl NO3 NH4 PO4 Na KaCa2B Cn Fe

PHASE I

DATA PRESENTATION

Page	Line	Description
2	1	Total number of water sources in 1st 12 c's. Maximum number of sources is 5 (Form III).
2	2	Names of sources in 5 column blocks, starting with the 1st column (Form III).
2 3	3-10 1-15	Constituent concentrations (mg/l) for source water(s). Use as many lines as needed to complete concentration summary of source 1, 2, etc. Be sure to follow the same constituent order as listed on page 1. Place all numbers in 12 block c's (Form III).

NUMBER OF SOURCES

12

NAMES OF SOURCES

CALA WELLS

SOURCE WATER QUALITY
(mg/1)

0	0	0	0	730	01.2	
93	01.12	0.1	0.1	110	330	
0.1	.01	.013				
0	0	0	0	568	01.12	
183	20	0.1	2	72	308	
0.1	.01	.01				

PHASE I

DATA PRESENTATION

Page	Line	Description
4 5	1-15 1-15	Repeat same procedures for required discharge qualities as used for sources on preceding pages (Form IV).
6	1	Number of activities in 1st 12 c's (Form 0).
7	1	Activity code in 1st 5 c's. Activity name in columns 11-35 (Form 0). A page 7 is needed for each activity.
7	25	Water demanded by the activity in gallons per hour for all hours for which flow is known. Place zeros for hours of no flow. Place -1 where flow is not known. At least one hourly flow must be entered. Flows should be placed in 12 col blocks (Form II). or Water demanded by the activity in thousands of gallons per month for all months the flow is known. Place zero's for months with no flow. Place one's for months the flow is not known. At least one monthly flow must be entered. Flows should be placed in 12-column blocks (Form II).
7	6-10	Repeat same procedure as above for wastewater discharged from the activity (Form II).

NUMBER OF FINAL DISCHARGES

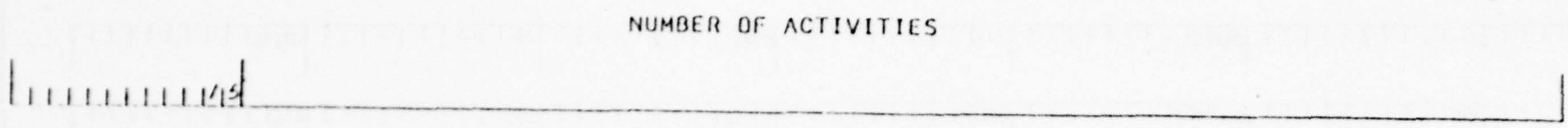
3

NAMES OF FINAL DISCHARGES

KILN RIVER GOLF

REQUIRED FINAL DISCHARGE QUALITY

200	500	10	250	1000	30	
500	30	20	20	500	800	
2	1	50				
20	50	0.1	20	1000	10	
200	20	5	5	200	800	
1	0.2	5				
30	60	0.5	50	2000	30	
350	-1	20	-1	350	-1	
3	.9	10				


NUMBER OF ACTIVITIES

ACTIVITY DATA

ACTIVITY CODE AND NAME

(DAILY PROGRAM)

[illegible] BASE HOUSING

WATER IN

(GPH)

10000	5000	5000	5000	10000	30000
70000	70000	70000	60000	50000	40000
40000	40000	40000	40000	50000	50000
50000	40000	40000	30000	30000	10000

WASTEWATER OUT

(GPH)

9000	4500	4500	4500	9000	27000
63000	63000	63000	54000	45000	36000
36000	36000	36000	36000	45000	45000
45000	36000	36000	27000	27000	9000

ACTIVITY DATA

ACTIVITY CODE AND NAME

(YEARLY PROGRAM)

WATER IN

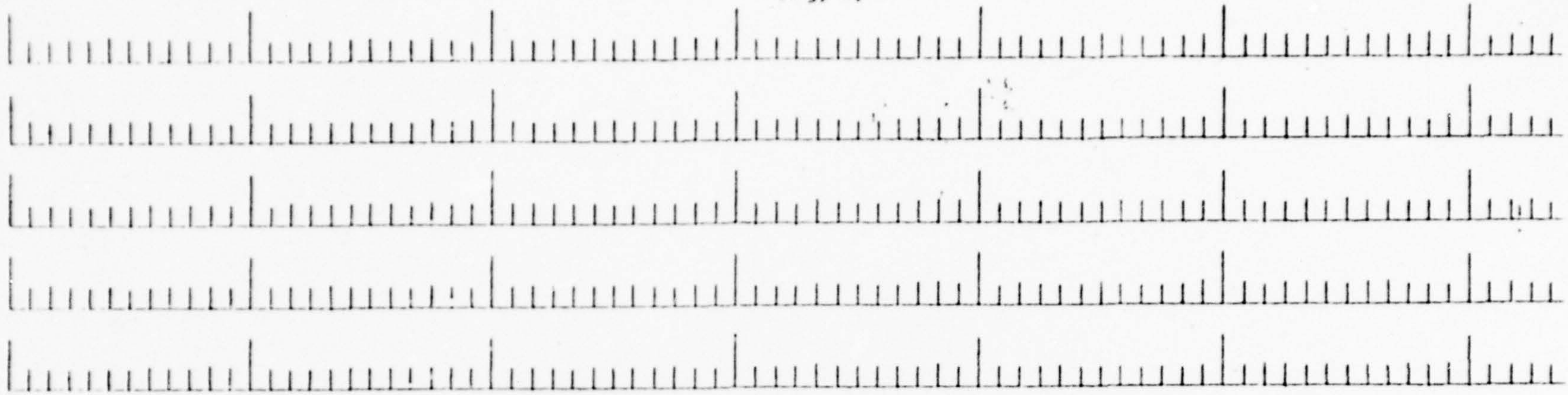
(1,000 GAL/MONTH)

30000	30000	30000	35000	35000	36000
40000	45000	50000	45000	40000	30000

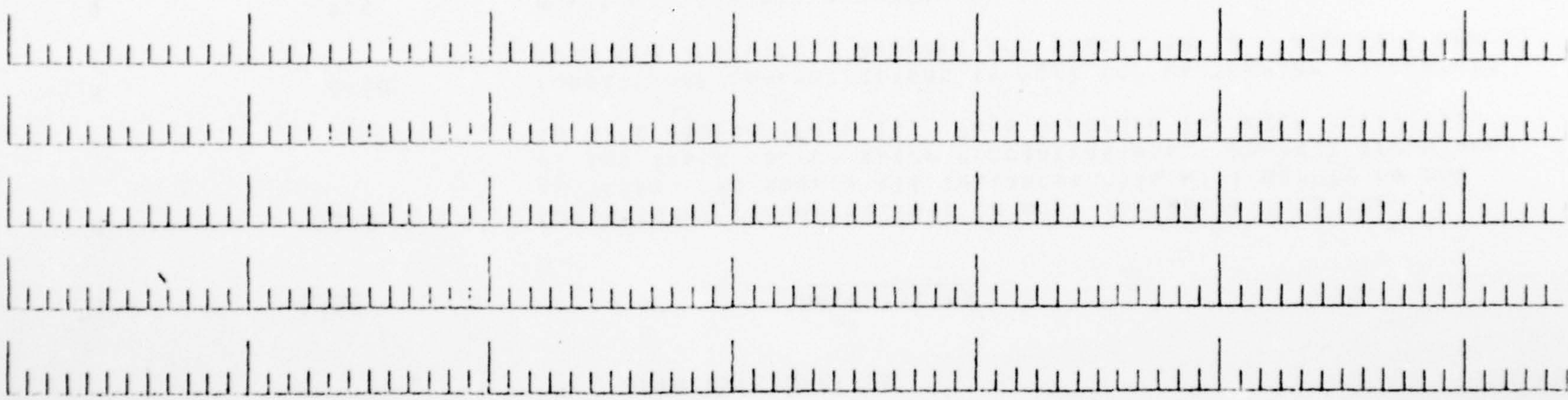
WASTEWATER OUT

(1,000 GAL/MONTH)

CONTAMINANTS IN
(mg/1)



CONTAMINANTS OUT
(mg/1)



PHASE I

DATA PRESENTATION

Page	Line	Description
8	1-5	Constituent concentrations in mg/l for water into the activity. In nearly all instances this will merely be one of the fresh source water concentrations. Numbers are placed in 12 c blocks (Form I). Page 8 needed for each activity.
8	6-10	Constituent concentrations in mg/l for wastewater discharged from the activity. Numbers are placed in 12 c blocks (Form I).
9	1-5	Maximum tolerable constituent concentrations for water into the activity. Numbers are placed in 12 c blocks (Form I). A page 9 needed for each activity.

Repeat pages 7-9 for all activities.

CONTAMINANTS IN
(mg/1)

.1	1	.001	1	600	.1	
1.85	5	.1	3	70	150	
.1	.005	.3				

CONTAMINANTS OUT
(mg/1)

200	300	.15	200	900	.5	
340	10	30	5	72	160	
.1	.01	.5				

TOLERABLE CONTAMINANT LEVELS
(mg/1)

1	B	.1901	1	1.900	.1	
450	4.5	.1	3	2.50	200	
.1	.2	.13				

PHASE 1

DATA PRESENTATION

Page	Line	Description
10	1	Number of regular treatment chains being used placed in 1st 12 c's. Maximum number of regular treatment chains is 7.
10	2	Names of regular treatment chains in 10 column blocks (Form VI).
10 11 12	3-7 1-15 1-15	Removal percentages for all constituents by each regular treatment chain. 12 col blocks. Note, begin a new line for each treatment chain (Form VI).
		Be sure constituents and chains are taken in the initial order of their listing. Numbers are placed in 12 col blocks.
13 14	1,2 1-5	Same as page 10 for special treatment units. Removal percentages for all constituents by each special treatment chain (Form V).
14	6-10	Threshold concentrations over which program will assume a special treatment is necessary at an activity. A concentration (mg/l) or a -1 (specifying) must be used for every constituent and each special treatment. Numbers are placed in 12 block c's (Form VII).
15-20	1-15	Same as page 14 for all special treatment units (Form VII).

TREATMENT DATA

NUMBER OF REGULAR TREATMENT CHAINS

2

NAMES OF REGULAR TREATMENT CHAINS

PRIMARY	SECONDARY						

REGULAR TREATMENT CHAIN REMOVAL PERCENTAGES

30	30	30	70	0	50
0	0	5	0	0	0
10	10	10			
85	80	75	85	0	75
0	0	75	20	0	0
10	80	60			

NUMBER OF SPECIAL TREATMENT

1

NAMES OF SPECIAL TREATMENTS

CHEM CLEANING

Output

Output from the Phase I Program fully describes the activities and possible cascade arcs.

The tables on the following pages are examples of the information provided.

Table 1 shows a summary of the hourly and cumulative flows into and out of each activity. In addition, graphs of these flows are provided. The aircraft wash rack shown here, used only 3,000 gal per day to wash one or two planes in the middle of the day. Some water was lost of evaporation and runoff as only 2,400 gal was discharged.

Table 2 provides a water-quality summary for each activity. The following information is shown:

- Tolerable source water concentrations. The aircraft wash rack, for example, is estimated to be able to accept water with BOD and SS of 20 mg/l.
- Actual concentrations into the activity.
- Actual concentrations out of the activity.
- Degradation through the activity in mg/l.
- Quantity of contaminants into and out of the activity, and degradation in lbs/day.

Table 3 delineates activity wastewater concentrations after various levels of treatment; none, primary, secondary, and three tertiary systems are shown in the example. As can be seen, this wash rack discharged a very strong waste that had a significant COD concentration (337 mg/l) even after carbon adsorption tertiary treatment. The treatment chains shown in Table 3 are additive, i.e., the carbon adsorption heading represents carbon adsorption added on to filtration and secondary treatment.

Table 4 shows the same type of data as Table 3 except, in this case, the program has assigned chemical coagulation pretreatment to the aircraft wash rack wastewater which then proceeds through the other regular treatment chains. The effect of the pretreatment alone can be gauged by comparing the "none" columns (no regular treatment) on Tables 3 and 4.

SPECIAL TREATMENT REMOVAL PERCENTAGES

50	50	30	70	0	20
0	0	0	85	0	0
0	0	0			

SPECIAL TREATMENT THRESHOLD CONCENTRATIONS

1/000	2000	1-1/	1/000	1-1/	1-1/
1-1/	1-1/	1-1/	1/000	1-1/	1-1/
1-1/	1-1/	1-1/			

Table 1

ACTIVITY WATER DEMAND AND WASTEWATER GENERATION

BASE: RANCH-AIR-FORCE-BASE

ACTIVITY: AIRCRAFT/AGE WASH RACK

ACTIVITY CODE: A/AWR

HOUR	WATER IN (GPH)	WASTEWATER OUT (GPH)	CUMULATIVE IN (GAL)	CUMULATIVE OUT (GAL)
1	0.	0.	0.	0.
2	0.	0.	0.	0.
3	0.	0.	0.	0.
4	0.	0.	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	0.	0.
8	0.	0.	0.	0.
9	1000.	800.	1000.	800.
10	1000.	800.	2000.	1600.
11	1000.	800.	3000.	2400.
12	0.	0.	3000.	2400.
13	0.	0.	3000.	2400.
14	0.	0.	3000.	2400.
15	0.	0.	3000.	2400.
16	0.	0.	3000.	2400.
17	0.	0.	3000.	2400.
18	0.	0.	3000.	2400.
19	0.	0.	3000.	2400.
20	0.	0.	3000.	2400.
21	0.	0.	3000.	2400.
22	0.	0.	3000.	2400.
23	0.	0.	3000.	2400.
24	0.	0.	3000.	2400.

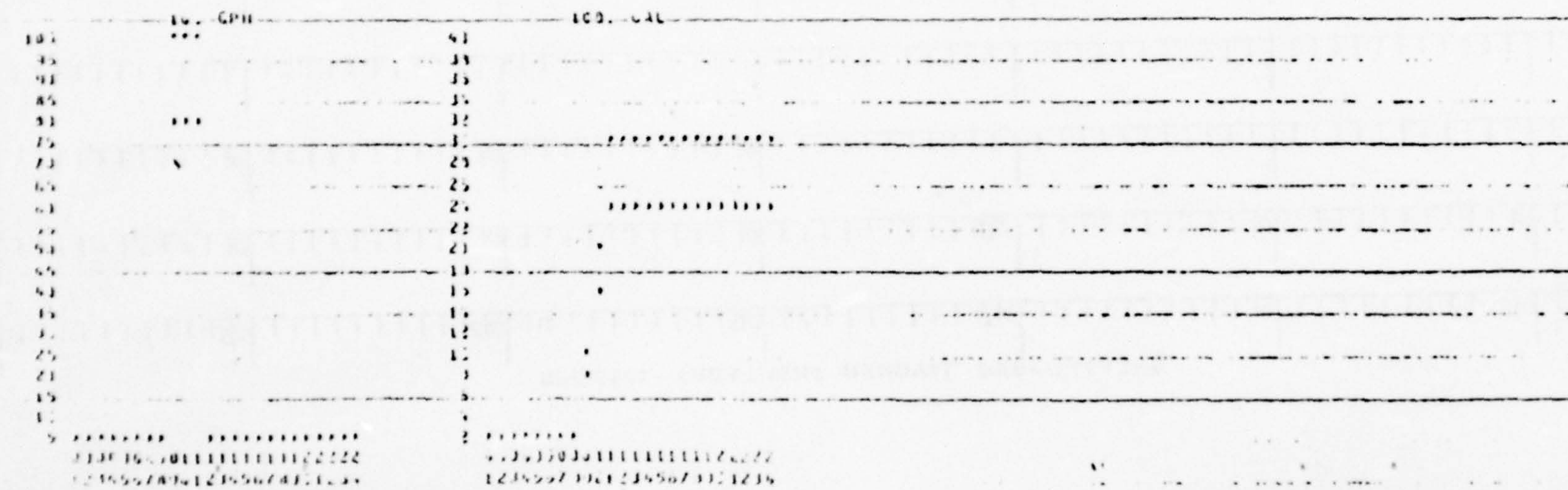


Table 2

WATER QUALITY SUMMARY

DATE

ACTIVITY: MARCH AIR FORCE BASE AIRCRAFT/AGE WASH RACK

ACTIVITY CODE: 4734C

	TOL(MG/L)	IN(MG/L)	OUT(MG/L)	DEGR(MG/L)	IN(LBS/DAY)	OUT(LBS/DAY)	DEGR(LBS/DAY)
BOD	20.000	0.000	5711.000	5711.000	0.000	114.380	114.380
COD	50.000	0.000	8414.000	8414.000	0.000	168.916	168.916
PHEN	1.000	0.000	8.500	8.500	0.000	.170	.170
SS	20.000	0.000	470.000	470.000	0.000	9.413	9.413
TDS	2,000.000	564.000	463.000	12.000	14.223	12.317	-2.203
O&G	10.000	.200	285.000	284.800	.005	5.708	5.703
CL	800.000	185.000	185.000	0.000	4.631	3.705	-.926
NO3	-1.000	20.000	25.000	5.000	.501	.501	0.000
NH3	15.000	.100	.100	0.000	.003	.002	-.001
PO4	-1.000	2.000	81.000	79.000	.051	1.622	1.572
NA	600.000	72.000	72.000	0.000	1.803	1.442	-.361
CACO3	500.000	308.000	308.000	0.000	7.711	6.169	-1.542
S	-1.000	.100	.100	0.000	.003	.002	-.001
CN	.500	0.000	0.000	0.000	0.000	0.000	0.000
ZN	40.000	.010	1.100	1.090	.000	.022	.022

Table 3

ACTIVITY WASTEWATER CONCENTRATIONS AFTER TREATMENT
(MG/L)

BASE	MARCH AIR FORCE BASE
ACTIVITY	AIRCRAFT/AGE WASH RACK
ACTIVITY CODE	A/A4C
SPECIAL TREATMENT	NONE

	NONE	PRIMARY	SECONDARY	FILTRATION	CARBON ADS	REV. OSMOS
BOD	5711.000	1197.710	856.650	162.660	37.110	6.000
COD	8516.000	5963.800	1686.400	1312.640	117.160	84.340
PHENOL	4.500	6.950	2.125	2.125	.530	.010
SS	474.000	141.600	72.500	9.400	[illegible]	[illegible]
TDS	660.000	630.000	630.000	490.000	410.000	54.000
O&G	285.000	142.500	71.250	42.750	11.400	8.550
CL	135.000	185.000	135.000	135.000	135.000	37.300
NO3	25.000	25.500	25.000	25.000	23.000	7.500
NH3	.100	.100	.005	.005	[illegible]	0.200
PO4	41.000	41.000	64.400	12.150	12.150	1.621
NA	72.000	72.000	72.000	72.000	72.000	18.000
CACO3	338.000	338.000	338.000	304.000	338.000	34.400
F	.100	.600	.392	.39	.39	.325
CN	0.000	0.000	0.000	0.000	0.000	0.100
CR	1.100	.700	.445	.4[illegible]0	.440	.044

Table 4

ACTIVITY WASTEWATER CONCENTRATIONS AFTER TREATMENT
(MG/L)

BASE: HANCH AIR FORCE BASE
ACTIVITY: AIRCRAFT/AGE WASH RACK
ACTIVITY CODE: A/3WE
SPECIAL TREATMENT: CHEM COAG

	NONE	PRIMARY	SECONDARY	FILTRATION	CARBON ADS	REV. OSMOS
BOD	2455.000	1478.850	524.125	171.000	21.555	2.000
COD	4217.000	2151.900	441.400	506.450	154.587	42.170
PHEN	5.450	4.165	1.404	1.403	.476	.476
SS	141.000	42.300	21.156	2.826	0.000	0.000
TDS	630.000	610.000	610.004	48.000	411.300	54.000
O&G	225.000	114.000	37.400	14.270	3.126	6.140
CL	145.000	145.000	145.000	145.000	113.000	37.000
NO3	25.000	25.000	25.000	25.000	21.000	7.500
DOS	.110	.100	.025	.025	0.000	0.000
PO4	12.150	12.100	4.720	1.820	1.821	.263
NA	72.000	72.000	72.000	72.000	72.000	10.000
CACO3	109.000	114.000	114.000	104.300	105.000	10.800
H	.120	.010	.090	.010	.040	.025
CU	3.000	3.000	0.100	0.000	1.000	0.300
FE	1.100	.010	.440	.400	.540	.144

As shown, chemical coagulation is specified as removing 50 percent of the BOD and COD and 70 percent of the suspended solids. The program assigns these pretreatments to activities whenever the raw discharge exceeds one of the pretreatment threshold concentrations designated by base personnel. Table 4 aids in determining the feasibility of activity pretreatment.

Table 5 summarizes the suitability of each activity effluent for reuse in other activities. The acceptability of each constituent for reuse after various levels of treatment is shown. This table aids the engineer in isolating troublesome contaminants and evaluating the effect of treatment on contaminant removal.

As shown in the example, under each treatment option, all base activity codes are listed vertically. An "X" means that the constituent is acceptable for reuse in the activity it falls under after going through the treatment designated. For example, looking at NO_3, it can be seen that the raw discharge from the aircraft wash rack is acceptable for reuse in all activities but the photo shop. Moving across the NO_3 now, one notices that NO_3 is sufficiently removed for use in photo processing only after the carbon adsorption chain. Similarly, COD is never acceptable for reuse regardless of treatment. An "X" for every constituent under one activity means that the entire effluent is acceptable for cascade to that activity.

For activities assigned pretreatment (i.e., chemical coagulation at the aircraft wash rack), a table similar to Table 5 is provided that assumes pretreatment is operative at the activity. This table allows engineers to easily evaluate the feasibility of pretreatment at an activity and its ability to enhance the quality of effluent for reuse. As shown in Table 6, the aircraft wash rack with chemical coagulation is now discharging acceptable water for reuse in several other activities after reverse osmosis (an unlikely event but one that shows the value of the table).

Table 7 is the key Phase I output table that condenses the output provided into one base summary table showing acceptable cascades between activities on the base. Activities are listed with pretreatment, if applicable. An "X" means that the effluent from the activity in that row is acceptable for cascade to the activity in the column, after the treatment designated.

A number "1" instead of an "X" indicates that only one constituent in the wastewater was not acceptable: a "2"

Table 5

SUITABILITY OF ACTIVITY EFFLUENT FOR REUSE

BASE: HANSCOM AIR FORCE BASE
ACTIVITY: AIRCRAFT/AGE WASH RACK
ACTIVITY CODE: A7A4C
SPECIAL TREATMENT: NONE

	NONE	PRIMARY	SECONDARY	FILTRATION	CARBON ADS	REV. OSMOS
	AHOOPAGVOGAH	AHOOPAGVOGAH	AHOOPAGVOGAH	AHOOPAGVOGAH	AHOOPAGVOGAH	AHOOPAGVOGAH
	/OOFHHEWFOHO	/OOFHHEWFOHO	/OOFHHEWFOHO	/OOFHHEWFOHO	/OOFHHEWFOHO	/OOFHHEWFOHO
	AUOFOHHRFLIS	AUOFOHHRFLIS	AUOFOHHRFLIS	AUOFOHHRFLIS	AUOFOHHRFLIS	AUOFOHHRFLIS
	WS T I IFRP	WS T I IFRP	WS T I IFRP	WS T I IFRP	WS T I IFRP	WS T I IFRP
	RE O R R R	RE O R R R	RE O R R R	RE O R R R	RE O R R R	RE O R R R
BOD						XXXXXXXXXXXX
COD						
PHEN			X X	X X	X X	X X
SS				X XXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
TDS	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
[illegible]					X XXX	X XXXXX
CL	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
NO3	XXXX XXXXXXX	XXXX XXXXXXX	XXXX XXXXXXX	XXXX XXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
[illegible]	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
PO4	X XXXXX	X XXXXX	X XXXXX	X XXXXX	X XXXXX	XXXXXXXXXXXX
[illegible]	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
[illegible]	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
[illegible]	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
CN	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
FE	X XXXXX	X XXXXX	X XXXXX	X XXXXX	X XXXXX	XXXXXXXXXXXX

Table 6

SUITABILITY OF ACTIVITY EFFLUENT FOR REUSE

BASE: BANGOR AIR FORCE BASE
ACTIVITY: AIRCRAFT/AGE WASH RACK
ACTIVITY CODE: A/A4C
SPECIAL TREATMENT: CHEM COAG

	NONE	PRIMARY	SECONDARY	FILTRATION	CARBON ADS	REV. OSMOS
	AHDOPAGVOGAH /00FHHEWFOHO AUQFOHHRFLIS WS T I IFRP RE O R R R	AHDOPAGVOGAH /00FHHEWFOHO AUQFOHHRFLIS WS T I IFRP RE O R R R	AHDOPAGVOGAH /00FHHEWFOHO AUQFOHHRFLIS WS T I IFRP RE O R R R	AHDOPAGVOGAH /00FHHEWFOHO AUQFOHHRFLIS WS T I IFRP RE O R R R	AHDOPAGVOGAH /00FHHEWFOHO AUQFOHHRFLIS WS T I IFRP RE O R R R	AHDOPAGVOGAH /00FHHEWFOHO AUQFOHHRFLIS WS T I IFRP RE O R R R
BOD					X XXX	XXXXXXXXXXXX
COD						X XXXXX
PH			X X	X X	X XXXXX	X XXXXX
SS		X XXX	X XXX	X XXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
TDS	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
O&G					X XXXXX	X XXXXX
CL	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
NO3	XXXX XXXXXXX	XXXX XXXXXXX	XXXX XXXXXXX	XXXX XXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
NH3	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
PO4	X XXXXX	X XXXXX	X XXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
HA	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
CACO3	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
F	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
CD	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
FE	X XXXXX	X XXXXX	X XXXXX	X XXXXX	X XXXXX	XXXXXXXXXXXX

Table 7

BASE SUMMARY

ACCEPTABLE CASCADES AT VARIOUS LEVELS OF TREATMENT

BASE: MARCH AIR FORCE BASE

	NONE	PRIMARY	SECONDARY	FILTRATION	CARBON ADS	REV. OSMOS
	AHJOPACVOGAH	AHJOPACVOGAH	AHJOPACVOGAH	AHJOPACVOGAH	AHJOPACVOGAH	AHJOPACVOGAH
	/OOFHHEWFOHO	/OOFHHEWFOHO	/OOFHHEWFOHO	/OOFHHEWFOHO	/OOFHHEWFOHO	/OOFHHEWFOHO
	AUDFOHHRFLIS	AUDFOHHRFLIS	AUDFOHHRFLIS	AUDFOHHRFLIS	AUDFOHHRFLIS	AUDFOHHRFLIS
	WS I I IFRP	WS I I IFRP	WS I I IFRP	WS I I IFRP	WS I I IFRP	WS I I IFRP
	RE O R R R	RE O R R R	RE O R R R	RE O R R R	RE O R R R	RE O R R R
AZARE						1 21222
... OIL+GREASE					2 2	1 11111
... CHEM COAG					2 12111	X XXXXX
[illegible]			X XXX	X XXXXX	X XXXXX	X222 2XXXXX2
[illegible]			X XXX	X XXXXX	X XXXXX	X222 2XXXXX2
[illegible]			X XXX	X XXXXX	X XXXXX	X222 2XXXXX2
[illegible]			2 22222	X 1X111	X 1X111	X222 21X1112
... METAL REM			2 22222	X 1X111	X 1X111	X1111111XXXX1
[illegible]			X XXX	X XXXXX	X XXXXX	X222 2XXXXX2
[illegible]				1 111	X XXXXX	X22222XXXXX2
[illegible]			X XXX	X XXXXX	X XXXXX	X222 2XXXXX2

means similarly that two constituents were over tolerable limits for cascade.

As shown in the sample table, the base housing effluent ("HOUSE") is acceptable for reuse after secondary treatment in all irrigational activities: general irrigation (GENIR), office area irrigation (OFFIR), golf course irrigation (GOLF), and Arnold Heights housing irrigation (AHIRR). The photo shop wastewater is acceptable for reuse as irrigation water after filtration tertiary treatment except for one constituent which proved to be cyanide.

This table should aid greatly in locating feasible cascades and pretreatments of most potential, as well as pinpointing cascades hindered by just one or two troublesome contaminants. Review of these individual activity summaries may show that the problem constituent can be eliminated or treated somehow to achieve an acceptable water for cascade.

These tables as output from Phase I should be valuable in helping base personnel construct feasible cascade reuse network diagrams.

Phase II

Base Input

Phase II input involves the representation of cascade networks to be analyzed and the specification of appropriate cost data.

Cost data that must be provided include the following:

. Rate of interest (%)
. ENR Construction Cost Index
. ENR Labor Cost Index
. Life of the system (yrs)
. Costs of regular and special treatment units or chains
. Costs of piping, pumping, and storage
. Cost per 1,000 gal for water supply and discharge

With the aid of the Phase I output, base personnel should be able to develop feasible cascade networks. These networks have to be presented in proper format along with all lengths and possible sizes of pipe not already existing in the system.

The most difficult part of data representation is the cascade network itself. The first step for base personnel is to draw flow diagrams of possible networks similar to the one shown in Figure 1 on the following page.

As shown, the network includes two types of units: activities (base housing, vehicle wash rack, etc.), and BTS's (Blending-Treatment-Storage Units). The BTS's are the crux of the network and full understanding of their placement and function is absolutely necessary.

BTS's are to be placed between any two connected activities, between activities and sources, and between activities and discharges. They serve as focal points for computer calculations of flow, storage, concentrations, treatment, and costs. Each BTS has a make-up line and an overflow in discharge lines. Figure 2 shows a blown-up view of a BTS and its simplification into a one-square symbol. Addition of makeup water can occur before or after treatment as specified by the engineer. A complete description of the mathematics involved with blending, treatment, storage, overflow, and make-up are discussed in Appendix 3.

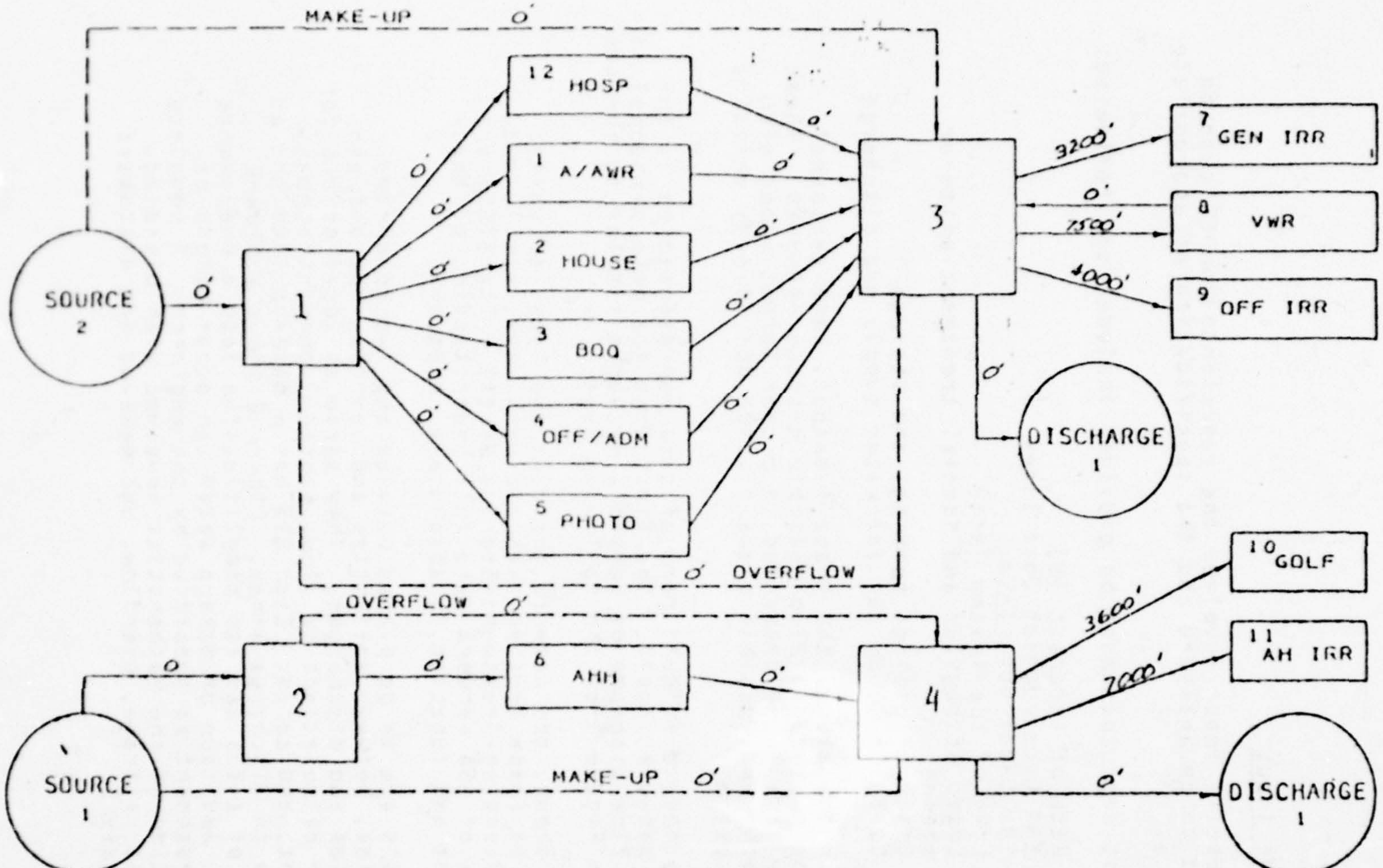
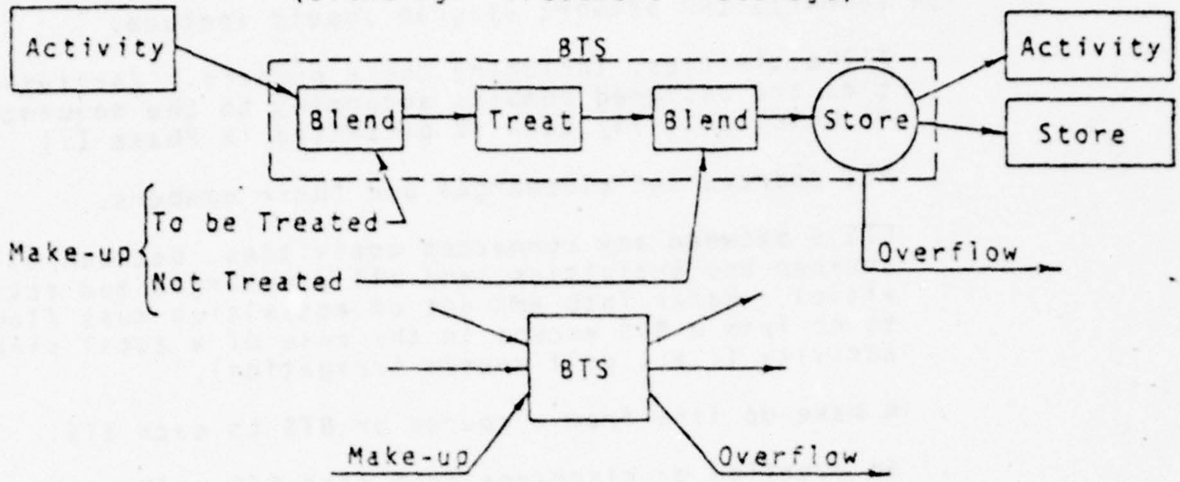


FIGURE 1
MARCH AFB
NETWORK NO. 1

FIGURE 2

BTS UNIT

(Blending - Treatment - Storage)



The network displayed in Figure 1 includes a total of 12 activities:

No.	Code	Name
1	A/AWR	Aircraft/age wash rack
2	HOUSE	Main base housing
3	BOO	Bachelor officers' quarters
4	OFF	Office/administration
5	PHOTO	Photographic processing
6	AHH	Arnold Hts. housing
7	GENIR	General grounds irrigation
8	VWR	Vehicle wash rack
9	OFFIR	Office/adm. grounds irrigation
10	GOLF	Golf course irrigation
11	AHIRR	Arnold Hts. irrigation
12	HOSP	Hospital

Also shown are the four BTS's, each with a make-up line and overflow or discharge. In actuality, Source 1 is Colorado River water with BTS 2 being the existing water treatment plant. Source 2 is well water with BTS 1 just a fresh water storage facility. BTS's 3 and 4 are the two existing base sewage treatment plants. The main purpose of this network was to test the feasibility of total effluent reuse for irrigation.

Piping lengths have been shown for new pipes. All other lines are assumed to be existing or non-functional, and were assigned 0 length.

It is important that all piping be given a length, even if it is zero.

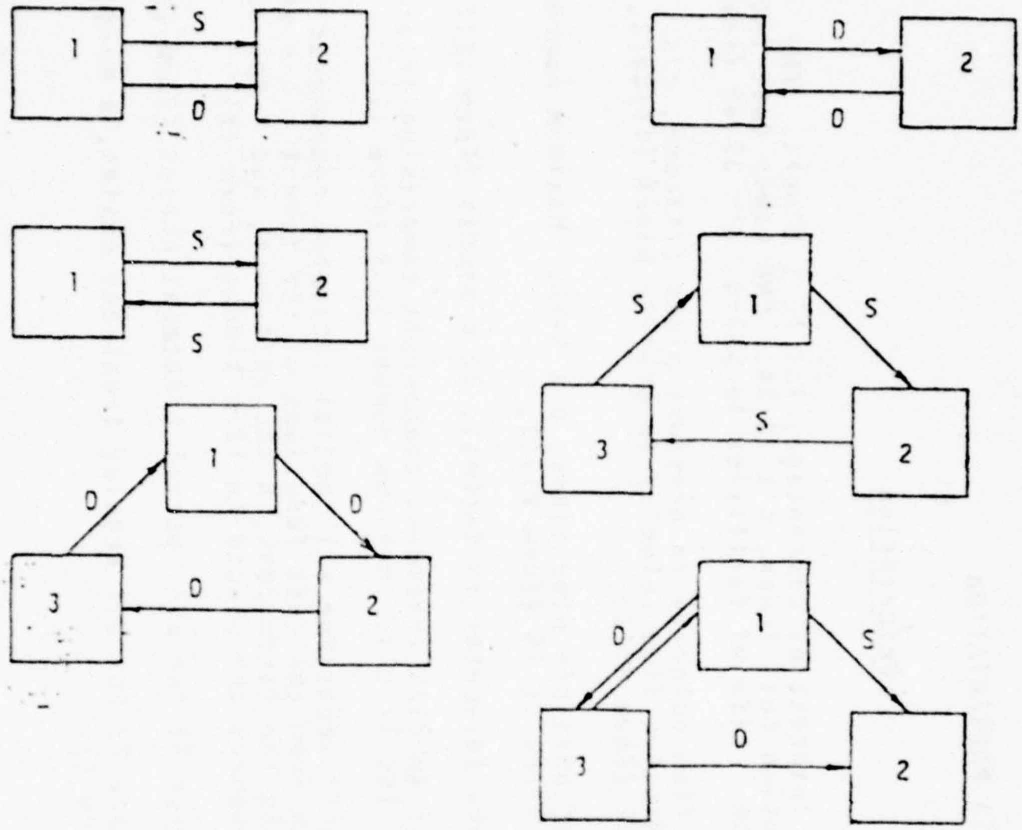
In summary, the network diagram should include:

- All activities, including their numbers. (Activities are assigned numbers according to the sequence in which activity data is presented in Phase I.)
- All sources and discharges and their numbers.
- BTS's between any connected activities, between all sources and activities, and all discharges and activities. Water into and out of activities must flow to or from a BTS except in the case of a total sink activity (i.e., golf course irrigation).
- A make-up line from a source or BTS to each BTS.
- An overflow or discharge from each BTS. (Note: One occurrence must be avoided--closed loops comprised of source and discharge lines between BTS's. A check to avoid this occurrence is to reverse the flow direction of all source lines to BTS's on the network diagram and to look for any closed loops comprised of BTS discharge lines and the reverse flow BTS source lines. See Figure 3 for examples of permissible and non-permissible loops.)
- All pipe lengths in the system. Zero length can be specified for existing lines.

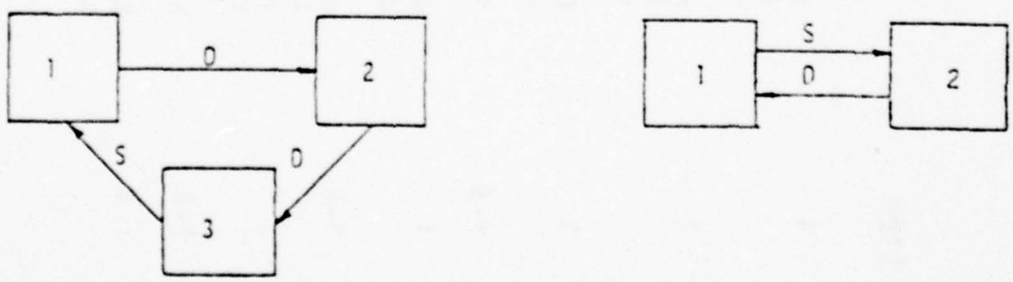
Proper translation of this network to a tabular format readable by the machine is described and illustrated in the following sections. Specific instructions follow for filling out all Phase II input forms. In each case, sample forms are provided for illustration.

FIGURE 3

EXAMPLES OF NON-PERMISSIBLE
CLOSED LOOP BTS NETWORKS



EXAMPLES OF PERMISSIBLE NETWORKS



Note: S = Water supply
d = Wastewater discharge

PHASE II

DATA PRESENTATION

Page	Line	Description
21	1	Rate of interest as percentage, 1st 12 c blocks. ENR Construction Cost Index, c's 13-24. ENR Labor Cost Index, c's 25-36. Life of facilities in years, c's 37-48 (Form VIII).
21	2	Maximum flow velocity in pressure pipes (ft/sec), c's 1-12. Maximum flow velocity in gravity pipes (ft/sec), c's 13-24 (Form VIII).
21	3	Number of possible pipe sizes, c's 1-12. Maximum number of pipe sizes is 15 (Form VIII).
21	4-6	Pipe sizes (diameter in inches), 12 c blocks (Form VIII).
22	1	Number of special treatment components comprising treatment chain in 1st 12 c's. Maximum number is 7 (Form IX).
22	2-8	Cost coefficients for all special treatment components in the chain from the cost functions of the form $\$ = A + BQ^C$ where A is the fixed cost, B the unit cost, and C the scale cost. Numbers are placed in 12 c blocks (Form IX).
23-28	1-8	Repeat page 22 for all special treatment chains (Form IX).
29-35	1-8	Repeat page 22 for all regular treatment chains, a maximum of 7 (Form X).

COST DATA

% INTEREST	CCI	LCI	LIFE (YEARS)
10	2193	4.71	20

MAX. VELOCITY IN PIPES (FT/SEC)

5	3

NUMBER OF PIPE SIZES

12

PIPE SIZES

1	2	3	4	6	8
10	12	15	18	24	36

SPECIAL TREATMENT COSTS

NUMBER OF TERMS

1

COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE
0	1315	.41	16.214	21.138	1

PHASE II

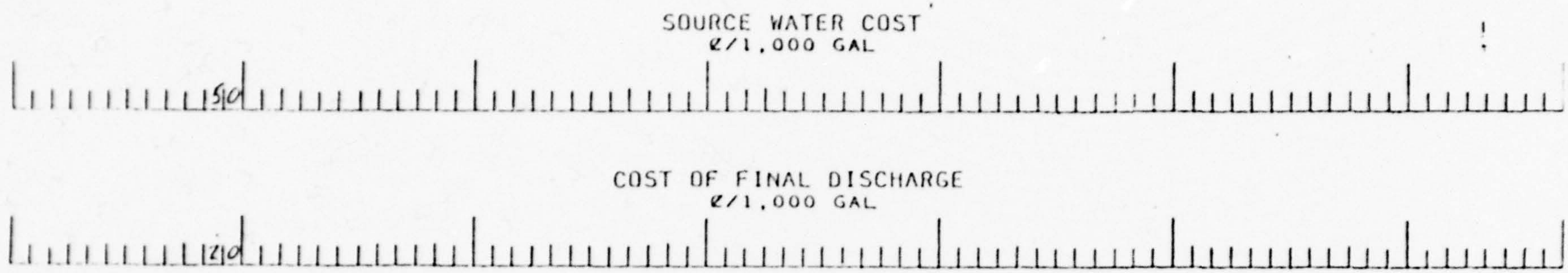
DATA PRESENTATION

Page	Line	Description
36	1	Cost of water (¢/1000 gal) for each source, 1st 12 c block (Form III).
36	2	Cost of final discharge (¢/1000) gal for each final effluent, 1st 12 c block (Form IV).
37	1	Number of BTS's in network, 1st 12 c block. Maximum number of BTS's is 20 (Form XI).
38	1	Number of activities out of 1st BTS, c's 1-12. The number of source feeding BTS 1, c's 13-24. If another BTS is the source, then put that BTS number in preceded by a minus sign. The number of discharge taking water from BTS 1, c's 25-36. If another BTS is accepting the overflow or discharge, then put that BTS number in preceded by a minus sign (Form XI).
		C's 37-48 are provided for specification of regular treatment at the BTS (Form XIII):
		. 0 denotes no treatment specified by the user. Let program calculate necessary removals and facilities.
		. 1, 2, up to 7 (number of regular treatment chain) denotes that user is specifying the removals provided by that treatment chain at BTS 1. Program will calculate required removals regardless, compare them to those specified, and select the larger for each constituent.
		. -1 denotes that user is specifying particular removal percentages at BTS 1. Again, program will calculate removals required, compare to those specified, select the larger for each constituent.

PHASE II

DATA PRESENTATION

Page	Line	Description
38	1	Column 60, place T if make-up water to BTS is to be treated at that BTS; F if make-up water is to by-pass treatment and to be blended with treated effluent from the BTS (Form XIV).
38	2	C's 1-12, number of 1st activity out of BTS 1 (numbers must coincide to activity number from initial activity list) (Form XI).
		C's 13-24 number of BTS accepting discharge from that activity. If activity is a total sink (i.e., golf course), then denote BTS out by a zero (Form XI).
		C's 25-72 continue same procedure for 2nd and 3rd activity out of BTS (Form XI).
38	3-6	Continue same procedure as line 2 for remaining activities out of BTS.
39	1-5	If regular treatment removals have been specified by user (-1 in c 48 of line 1), these percent removals are placed in 12 c blocks (Form XIII).
40-57	All	Repeat pages 38 and 39 for each BTS in the network. Note that if no treatment is specified, then page 28 is not necessary.


SOURCE WATER COST
¢/1,000 GAL
COST OF FINAL DISCHARGE
¢/1,000 GAL

NETWORK SUMMARY

NUMBER OF BTS'S

BTS No. 1 (Page repeated for BTS's 2,3, and 4

#ACTIVITIES OUT	SOURCE #	DISCHARGE #	REGULAR TREATMENT	MAKE-UP TREATMENT
17	2	1-13	1-17	F

ACT. OUT	BTS OUT	ACT. OUT	BTS OUT	ACT. OUT	BTS OUT
1/12	3	1	3	12	3
3	3	14	3	5	3
8	3				

SPECIFIED BTS TREATMENT REMOVALS (OPTIONAL)

85	80	75	85	0	75
0	0	95	20	0	0
10	80	60			

PHASE I

DATA PRESENTATION

Page	Line	Description
58	1	For activity No. 1, specify pretreatment at the activity by placing either a zero for no treatment or the number of the desired special treatment unit in c's 1-12. Repeat for activities 2-6 in the remaining 12 c blocks (Form XII).
58	2-6	Repeat line 1 for remaining activities in numerical order (Form)
59	1-5	Length in feet for pipe into each activity. If piping already exists, use zero length. Be sure to take activities in numerical order. Lengths are placed in 12 c blocks (Form XI).
60	6-10	Same as c's 1-5 above for length of pipe out of each activity (Form XI).
61	1-5	Length in feet for pipe supplying make-up to each BTS. If piping already exists, use zero length. Be sure to take BTS's in numerical order. Lengths are placed in 12 c blocks (Form XI).
62	6-10	Same as c's 1-5 but for overflow pipes from BTS's (Form XI).
63-87	All	Repeat pages 38-62 for second network.
Remaining	All	Repeat pages 38-62 for all remaining networks.
Last	1	Minus 1 in first c. Ends data.

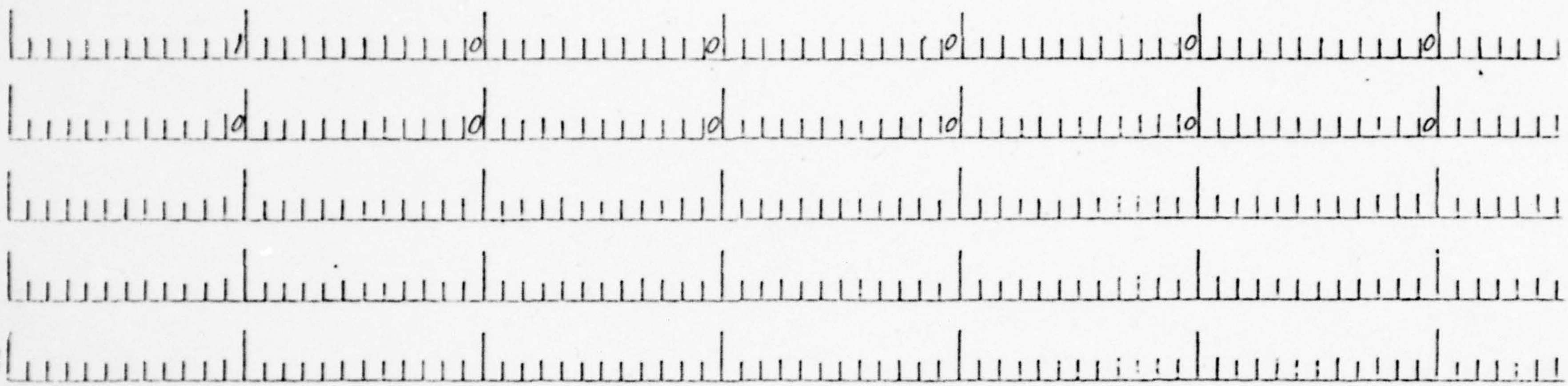
PIPE LENGTHS INTO ACTIVITIES

1000	500	0	0	0	5000	
2000	100	750	1000	500	1200	

PIPE LENGTHS OUT OF ACTIVITIES

2000	1000	100	2000	500	0	
0	1000	850	0	0	5000	

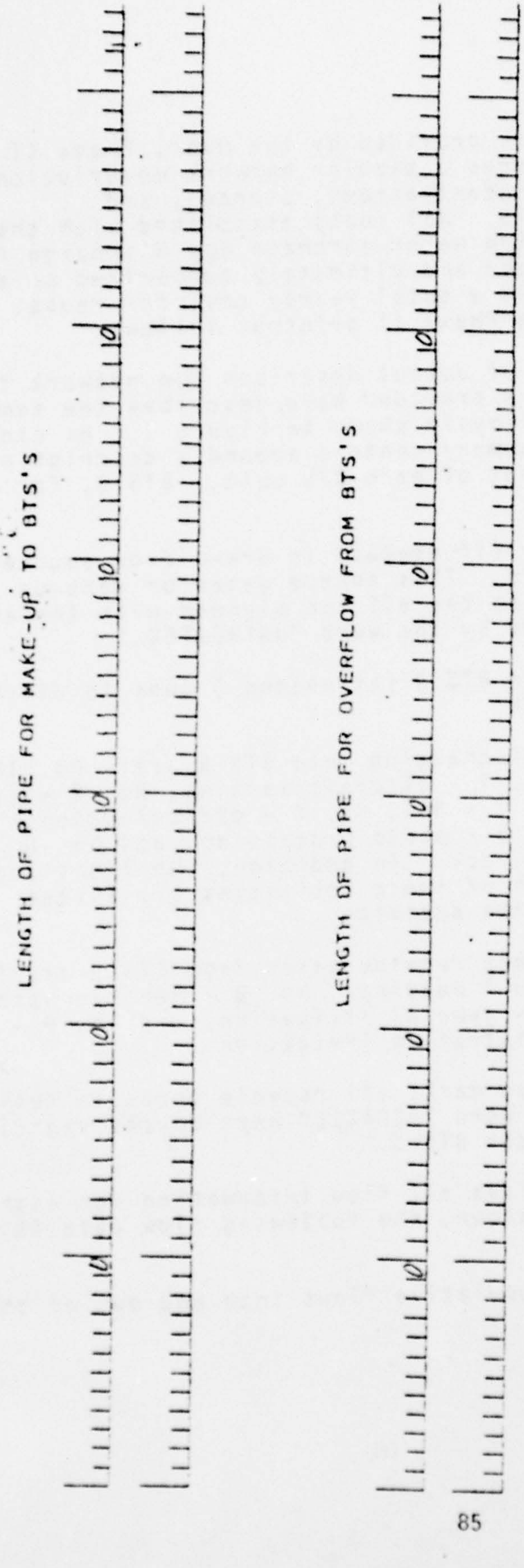
PRE-TREATMENT AT ACTIVITIES



03

LAST CARD OF DATA DECK

-1/


LENGTH OF PIPE FOR MAKE-UP TO BTS'S
LENGTH OF PIPE FOR OVERFLOW FROM BTS'S
10
10
10
10
10
10
10
10
10
10

Output

For each network provided by the user, Phase II of the program produces a tabular network description and summarizes flows, concentrations, storage, and treatment at each BTS. All costs associated with the reuse system including water purchase and discharge fees are clearly delineated and ultimately summarized on an annual basis to yield a total yearly cost for reuse. A description of the Phase II printout follows.

The first page of output describes the network to be evaluated. Table 8, provided here, describes the sample cascade network previously shown in Figure 1. As can be seen, the network summary centers around a description of the flows into and out of each BTS unit. BTS 3, for example, shows the following:

- Source water (if needed) is drawn from source No. 2 - Wells. This source water or make-up is not treated at the BTS but blended with the effluent as designated by the word "UNTREATED."

- Overflow from BTS 3 (if needed) goes to discharge No. 1 - DISCH.

- Activities discharging into BTS 3 are: No. 12 - hospital, No. 1 - aircraft washing, No. 2 - base housing, No. 3 - BOQ, No. 4 - office/administration, No. 5 - photo processing, and No. 8 - vehicle wash rack. In addition, the BTS's supplying water to each of these activities are listed adjacent to the activity.

- Activities that receive water from BTS 3 are listed under the "OUT" heading: No. 8 - vehicle wash rack, No. 7 - general irrigation, and No. 9 - office/administration irrigation.

- The table also marks all recycle loops as designated by the word "RECYCLE" next to the vehicle wash rack under BTS 3.

Table 9 summarizes all flow information for each BTS in the network. As shown, the following flow data is provided:

- Hourly and cumulative flows into and out of the BTS

TABLE 8

WATER DISTRIBUTION NETWORK NO. 1

MARCH AIR FORCE BASE

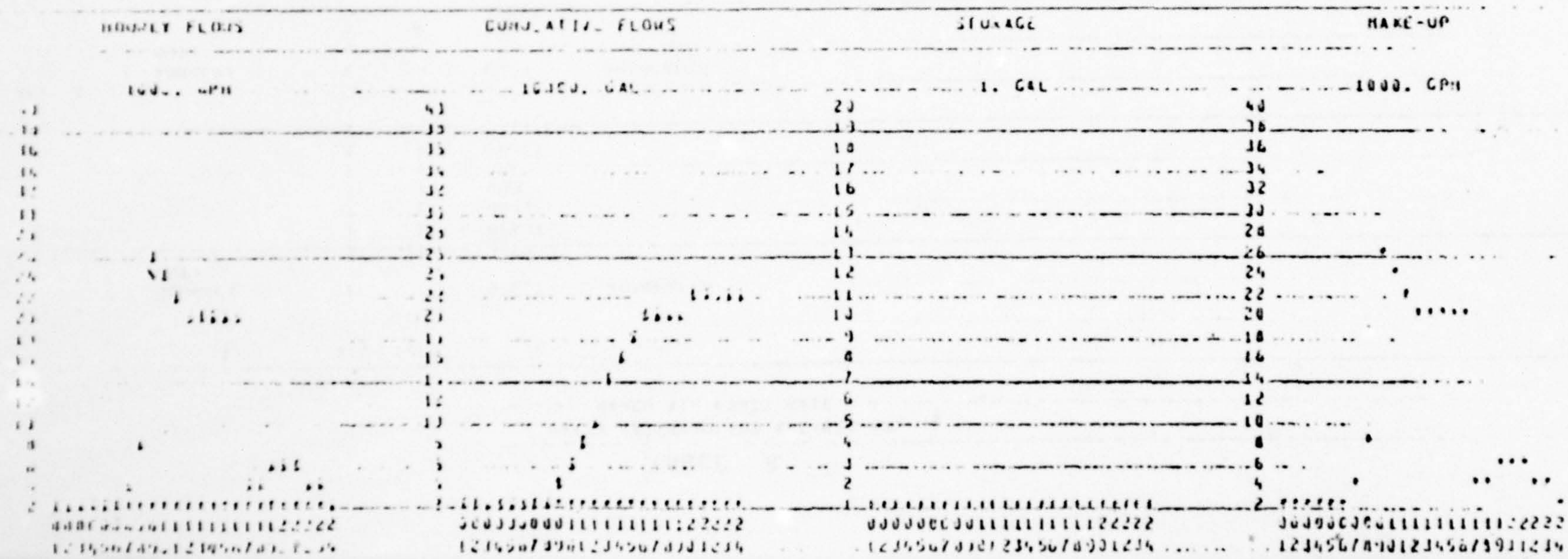
		RES	ACT.		
RES. 1					
	SOURCE:	2		WELLS	UNTREATED
	OUT:				
		1	12	HOSP	
		1	1	A/AAR	
		1	2	HOUSE	
		1	3	BOQ	
		1	4	OFF	
		1	5	PIRIED	
		1		OVERFLOW	
RES. 2					
	SOURCE:	1		COLO	UNTREATED
	OUT:				
		4	6	AHI	
		4		OVERFLOW	
RES. 3					
	SOURCE:	2		WELLS	UNTREATED
	OVERFLOW:	1		DISCH	
	IN:				
		1	12	HOSP	
		1	1	A/AAR	
		1	2	HOUSE	
		1	3	BOQ	
		1	4	OFF	
		1	5	PIRIED	
		1	5	VAR	
		1		OVERFLOW	
	OUT:				
		3	8	VAR	RECYCLE
		3	7	GENER	
		3	3	OFFIR	
RES. 4					
	SOURCE:	1		COLO	UNTREATED
	OVERFLOW:	1		DISCH	
	IN:				
		2	6	AHI	
		2		OVERFLOW	
	OUT:				
		3	1.	GOLF	
		3	11	AHIER	

TABLE 9

FLOW SUMMARY FOR DAY 1

HOUR	IN (GPH)	OUT (GPH)	CUM IN (GAL)	CUM OUT (GAL)	ADJ IN (GPH)	ADJ CUM IN (GAL)	MIN STOR (GAL)	MAX STOR (GAL)	MAKE-UP (GPH)
1	0.	800.	0.	800.	800.	800.	0.	0.	800.
2	0.	800.	0.	1600.	800.	1600.	0.	0.	800.
3	0.	800.	0.	2400.	800.	2400.	0.	0.	800.
4	0.	800.	0.	3200.	800.	3200.	0.	0.	800.
5	0.	800.	0.	4000.	800.	4000.	0.	0.	800.
6	0.	1300.	0.	5300.	1300.	5300.	0.	0.	1300.
7	0.	1200.	0.	6500.	1200.	6500.	0.	0.	1200.
8	0.	10000.	0.	16500.	10000.	16500.	0.	0.	10000.
9	0.	26000.	0.	42500.	26000.	42500.	0.	0.	26000.
10	0.	24000.	0.	66500.	24000.	66500.	0.	0.	24000.
11	0.	23200.	0.	89700.	23200.	89700.	0.	0.	23200.
12	0.	20200.	0.	109900.	20200.	109900.	0.	0.	20200.
13	0.	20200.	0.	130100.	20200.	130100.	0.	0.	20200.
14	0.	20200.	0.	150300.	20200.	150300.	0.	0.	20200.
15	0.	20200.	0.	170500.	20200.	170500.	0.	0.	20200.
16	0.	20200.	0.	190700.	20200.	190700.	0.	0.	20200.
17	0.	3200.	0.	193900.	3200.	193900.	0.	0.	3200.
18	0.	4800.	0.	198700.	4800.	198700.	0.	0.	4800.
19	0.	6400.	0.	205100.	6400.	205100.	0.	0.	6400.
20	0.	6400.	0.	211500.	6400.	211500.	0.	0.	6400.
21	0.	6400.	0.	217900.	6400.	217900.	0.	0.	6400.
22	0.	4800.	0.	222700.	4800.	222700.	0.	0.	4800.
23	0.	3700.	0.	226400.	3700.	226400.	0.	0.	3700.
24	0.	800.	0.	227200.	800.	227200.	0.	0.	800.

EXCESS STORAGE REQUIRED 0. GALLONS REQUIRED STORAGE CAPACITY 0. GALLONS



. Modified flows into or out of the BTS due to the effects of storage or make-up

. Minimum storage capacity and required capacity to provide a safety factor

. Required hourly make-up water if necessary

. Graphs of the above

In the example shown here, no storage was required, but make-up was needed as can be seen by the hourly flows under the last column.

Table 10 delineates source water usage on an hourly basis for a typical day. The "SUMMARY" section on the left side of the table gives a comparison of water usage for a once-through network with no reuse versus the cascade network and displays the water saved by reuse. On the right side of the table, hourly water drawn from each source is listed.

Table 11 supplies the same information as Table 9 for final effluent discharged from the base. Again, a comparison is made between a once-through and the cascade system.

Table 12 summarizes the following for each BTS in a network:

. Removal percentages specified by base personnel. As previously discussed, removals may be specified either by designating a treatment chain to be used at a BTS, or individual-constituent removals.

. Actual removals used at the BTS to meet all tolerable requirements. If removals are specified in the first column, the program will compare these percentages with those calculated as necessary and place the higher one in column two in each case.

. The most-stringent tolerable concentration required in the BTS effluent for each constituent.

This table is valuable in that it shows in concise form the degree of treatment necessary at each BTS. From this table, base personnel can isolate those constituents forcing higher levels of treatment and investigate activity pretreatment options to reduce a critical contaminant and perhaps lower the level of BTS treatment.

Table 11

EFFLUENT DISCHARGE
(GPD)

	SUMMARY			INDIVIDUAL DISCHARGES
	ONCE THROUGH	CASCADE	NET SAVINGS	DESIGN
1	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]
21	[illegible]	[illegible]	[illegible]	[illegible]
22	[illegible]	[illegible]	[illegible]	[illegible]
23	[illegible]	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]

Table 12

CONCENTRATION SUMMARY FOR ITS

	SPEC. REMOVAL	REMOVAL	TOLERABLE (MG/L)
BOD	0.%	87.%	33.03.
COD	0.%	76.%	53.03.
PHEN.	0.%	0.%	.53.
SS	0.%	69.%	58.33.
TDS	0.%	0.%	2186.63.
OIL	0.%	0.%	12.03.
CL	0.%	0.%	356.03.
NO3	0.%	0.%	-1.63.
NH3	0.%	19.%	23.63.
PO4	0.%	0.%	-1.63.
NA	0.%	0.%	353.03.
CACO3	0.%	0.%	-1.00.
[illegible]	0.%	0.%	3.03.
CN	0.%	0.%	.013
FE	0.%	0.%	10.003

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SUBPOTABLE WATER REUSE AT ARMY FIXED INSTALLATIONS: A SYSTEMS A--ETC(U)
AUG 79 C J SCHMIDT, E V CLEMENTS, L HAMME DAMD17-78-C-8080

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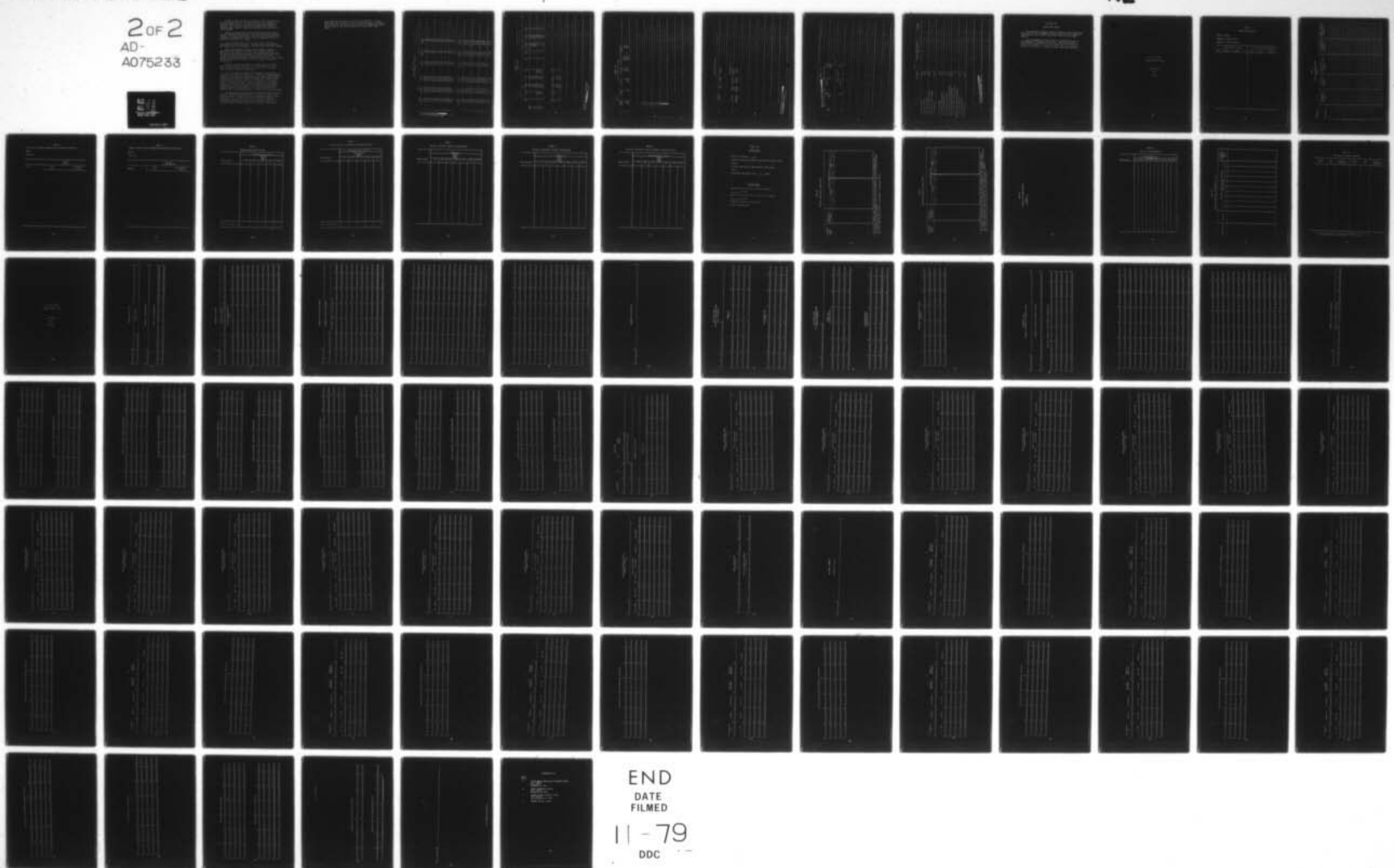

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Table 13 shows an hourly summary of the concentration of each constituent as it enters the BTS, as it exits BTS treatment, and as it is finally discharged from BTS storage. In this way, the hourly fluctuations and effects of peak loads on required treatment can more easily be evaluated.

Table 14 summarizes piping specifications and costs for the cascade reuse system. For each activity, the size, length, and cost of each pipe into and out of the activity is shown. In addition, similar data for make-up to and overflow from BTS's is listed.

Table 15 summarizes size and cost of all required storage facilities and pumps. Storage tank size includes the safety factor discussed in Section III of the main report.

Table 16 summarizes special pretreatment costs at activities and regular treatment chain costs at BTS's. As shown in the example, no activity pretreatment was specified and the program selected the carbon adsorption chain for BTS 3 and the secondary treatment chain for BTS 4 as being the least expensive treatment to meet all requirements. Costs are summarized on both a total capital and yearly O & M basis.

Table 17 summarizes costs for procurement and treatment of source water for each major source on the base, and also the costs associated with each final discharge from the base (excluding treatment).

Table 18 shows the major total system cost summary. Firstly, capital costs for piping, pumping, storage, regular treatment, and special pretreatment are listed and totaled. These capital costs are then translated into annual costs by applying the capital recovery factor that utilizes the cost information supplied by base personnel on interest rates and equipment life. Annual capital and O & M costs are added to source water and discharge costs previously summarized to provide a total yearly cost for the entire cascade network. This cost can be used to compare the benefits and cost effectiveness of different cascade networks.

As can be seen in the example provided, another heading labeled "EXISTING FACILITIES COST" is also provided. In the case where portions of the cascade network are already existing (i.e., source water pumps, secondary sewage treatment plants, etc.), the costs for facilities can be listed and subtracted from the cost summary to obtain the "NET COST" for the cascade reuse system. Many bases

have some type of central wastewater treatment. In the case where the program calls for a more advanced treatment chain than that existing, only the cost of upgrading should be assigned to the reuse system and listed under "NET COST."

TABLE 13

CONCENTRATIONS THROUGH UTS 1

(MG/L)

	TDS			DOC		
	INTO TREATMENT	OUT OF TREATMENT	OUT OF STORAGE	INTO TREATMENT	OUT OF TREATMENT	OUT OF STORAGE
1	0.000	568.000	568.000	1.000	.200	.200
2	0.000	568.000	568.000	1.000	.200	.200
3	0.000	568.000	568.000	1.000	.200	.200
4	0.000	568.000	568.000	1.000	.200	.200
5	0.000	568.000	568.000	1.000	.200	.200
6	0.000	568.000	568.000	1.000	.200	.200
7	0.000	568.000	568.000	1.000	.200	.200
8	0.000	568.000	568.000	1.000	.200	.200
9	0.000	568.000	568.000	1.000	.200	.200
10	0.000	568.000	568.000	1.000	.200	.200
11	0.000	568.000	568.000	1.000	.200	.200
12	0.000	568.000	568.000	1.000	.200	.200
13	0.000	568.000	568.000	1.000	.200	.200
14	0.000	568.000	568.000	1.000	.200	.200
15	0.000	568.000	568.000	1.000	.200	.200
16	0.000	568.000	568.000	1.000	.200	.200
17	0.000	568.000	568.000	1.000	.200	.200
18	0.000	568.000	568.000	1.000	.200	.200
19	0.000	568.000	568.000	1.000	.200	.200
20	0.000	568.000	568.000	1.000	.200	.200
21	0.000	568.000	568.000	1.000	.200	.200
22	0.000	568.000	568.000	1.000	.200	.200
23	0.000	568.000	568.000	1.000	.200	.200
24	0.000	568.000	568.000	1.000	.200	.200

	CL			NO3		
	INTO TREATMENT	OUT OF TREATMENT	OUT OF STORAGE	INTO TREATMENT	OUT OF TREATMENT	OUT OF STORAGE
1	0.000	135.000	135.000	1.000	20.000	20.000
2	0.000	135.000	135.000	1.000	20.000	20.000
3	0.000	135.000	135.000	1.000	20.000	20.000
4	0.000	135.000	135.000	1.000	20.000	20.000
5	0.000	135.000	135.000	1.000	20.000	20.000
6	0.000	135.000	135.000	1.000	20.000	20.000
7	0.000	135.000	135.000	1.000	20.000	20.000
8	0.000	135.000	135.000	1.000	20.000	20.000
9	0.000	135.000	135.000	1.000	20.000	20.000
10	0.000	135.000	135.000	1.000	20.000	20.000
11	0.000	135.000	135.000	1.000	20.000	20.000
12	0.000	135.000	135.000	1.000	20.000	20.000
13	0.000	135.000	135.000	1.000	20.000	20.000
14	0.000	135.000	135.000	1.000	20.000	20.000
15	0.000	135.000	135.000	1.000	20.000	20.000
16	0.000	135.000	135.000	1.000	20.000	20.000
17	0.000	135.000	135.000	1.000	20.000	20.000
18	0.000	135.000	135.000	1.000	20.000	20.000
19	0.000	135.000	135.000	1.000	20.000	20.000
20	0.000	135.000	135.000	1.000	20.000	20.000
21	0.000	135.000	135.000	1.000	20.000	20.000
22	0.000	135.000	135.000	1.000	20.000	20.000
23	0.000	135.000	135.000	1.000	20.000	20.000
24	0.000	135.000	135.000	[illegible]	[illegible]	[illegible]

TABLE 1A

COST OF PIPE

	IN					OUT				
	SIZE (IN.)	LENGTH (FT.)	MAX FLOW (GPH)	COST/FT ($)	COST ($)	SIZE (IN.)	LENGTH (FT.)	MAX FLOW (GPH)	COST/FT ($)	COST ($)
AZAAR	2.	0.	1000.	4.00	0.	4.	0.	800.	8.00	0.
HOUSE	1.	0.	5000.	6.00	0.	4.	0.	5000.	8.00	0.
BOT	1.	0.	500.	2.00	0.	4.	0.	500.	8.00	0.
SFF	6.	0.	15000.	12.00	0.	6.	0.	15000.	12.00	0.
PHOTO	2.	0.	2000.	4.00	0.	4.	0.	2000.	8.00	0.
ATT	6.	0.	18000.	12.00	0.	6.	0.	18000.	12.00	0.
GENER	6.	3200.	14600.	12.00	38400.	0.	0.	0.	0.00	0.
VHE	1.	7500.	250.	2.00	15000.	4.	0.	225.	4.00	0.
OFFIC	4.	4000.	10500.	8.00	32000.	0.	0.	0.	0.00	0.
GOLF	16.	3600.	60000.	20.00	72000.	0.	0.	0.	0.00	0.
ANNEX	8.	7000.	28000.	16.00	112000.	0.	0.	0.	0.00	0.
HOSP	2.	0.	2500.	4.00	0.	4.	0.	2500.	8.00	0.

IES	SIZE (IN.)	LENGTH (FT.)	MAX FLOW (GPH)	COST/FT ($)	COST ($)
1	6.	0.	26600.	12.00	0.
2	6.	0.	18000.	12.00	0.
3	6.	0.	24300.	12.00	0.
4	10.	0.	59000.	20.00	0.

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TABLE 15

COST OF PUMPING AND STORAGE

NO.	STORAGE (GAL)	DIAMETER (FT)	STO. COST ($)	MAX. FLOW (GPH)	PUMP CAP COST ($)	PUMP O+M COST ($/YR)
1	0.	0.	0.	26000.	26899.	1636.
2	0.	0.	0.	18000.	22347.	843.
3	1232.	4.	1156.	25150.	26574.	1075.
4	76134.	33.	16500.	69000.	41759.	2324.

TABLE [illegible]

SPECIAL TREATMENT COSTS

ACT.	TREATMENT	FLOW (GPD)	CAP. COST ($)	O+M COST ($/YR)

TREATMENT COSTS

ST.	TREATMENT	FLOW (GPD)	CAP. COST ($)	O+M COST ($/YR)
1	CARBON ADS	224433.	1033213.	84857.
4	SECONDARY	281130.	646544.	54462.

TABLE 17

COST OF SOURCE WATER

		GPD	$/1000 GAL	$/YEAR
1	COLD	71150.	.50	136869.
2	WELLS	603213.	.49	107862.

COST OF DISCHARGE

		GPD	$/1000 GAL	$/YEAR
1	DISCH	0.	.15	0.

TABLE 10

	COST SUMMARY ($)	EXISTING FACILITIES COST ($)	NET COST ($)
CAPITAL COST OF PIPE	269900.		
CAPITAL COST OF PUMPING	117779.		
CAPITAL COST OF STORAGE	17356.		
CAPITAL COST OF REGULAR TREATMENT	1699717.		
CAPITAL COST OF SPECIAL TREATMENT	0.		
TOTAL CAPITAL COST	2104752.		
YEARLY COST FOR PIPE	29579.		
YEARLY CAPITAL COST FOR PUMPING	12375.		
YEARLY O&M COST FOR PUMPING	5144.		
YEARLY CAPITAL COST FOR STORAGE	1967.		
YEARLY CAPITAL COST FOR REGULAR TREATMENT	187255.		
YEARLY O&M COST FOR REGULAR TREATMENT	139748.		
YEARLY CAPITAL COST FOR SPECIAL TREATMENT	0.		
YEARLY O&M COST FOR SPECIAL TREATMENT	0.		
YEARLY COST OF SOURCE WATER	242756.		
YEARLY COST OF DISCHARGE	0.		
TOTAL YEARLY COST	619718.		

SECTION IV

BLANK DATA DECKS

This section includes a copy of each of the engineering forms that will be needed and also an entire blank computer form booklet, that contains at least one of every page needed.

It is extremely unlikely that all pages and lines of the computer form deck will be used. The data booklet is provided to accept the maximum amount of data that the program can handle. A typical network will use roughly one-third to one-half of the available deck provided here.

U.S. AIR FORCE

CASCADE WATER REUSE

ENGINEERING

FORM

BOOKLET

FORM O

BASE DESCRIPTION

Name of Base:

Number of Activities:

Number of Constituents:

List of Activities			List of Constituents		
No.	Code	Name	No.	Code	Name

FORM I

BASE: ____________________

ACTIVITY: ____________________

ACTIVITY WATER/WASTEWATER SUMMARY

Constituent	Source Water Concentration (mg/l)	Tolerable Concentration (mg/l)	Typical, Tolerable Concentration (mg/l)	Final Effluent Concentration (mg/l)	Typical, Final Effluent Concentrat (mg/l)
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
32.					
33.					

FORM II

DAILY ACTIVITY WATER DEMAND AND WASTEWATER GENERATION

Base:

Activity:

	Volume (gph)	
Hours	Water In	Wastewater Out

FORM II

YEARLY ACTIVITY WATER DEMAND AND WASTEWATER GENERATION

Base:

Activity:

	Volume (1,000 gal/mo)	
Months	Water In	Wastewater Out

FORM III

SOURCE WATER QUALITY/COST

Constituent	Concentration (mg/l) Sources Name (No.)				
	(1)	(2)	(3)	(4)	(5)
Cost: ¢/1000 gal					

FORM IV

FINAL EFFLUENT DISCHARGE REQUIREMENTS/COST

	Concentration (mg/1)				
	Discharges Name (No.)				
Constituent	(1)	(2)	(3)	(4)	(5)
Cost: ¢/1000 gal					

FORM V

SPECIAL TREATMENT REMOVAL PERCENTAGES

Constituent	Removal % Chain Name (No.) (1)	(2)	(3)	(4)	(5)	(6)	(7)

FORM VI

REGULAR TREATMENT REMOVAL PERCENTAGES

Constituent	Removal % Chain Name (No.)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)

FORM VII

SPECIAL TREATMENT CHAIN THRESHOLD CONCENTRATIONS

Constituent	Concentration (mg/l) Chain Name (No.)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)

FORM VIII

COST DATA

. Rate of interest: _____ %

. Current Engineering News Record Construction Cost Index:

. Current Engineering News Record Labor Cost Index:

. Estimated Equipment Life: ______ years

PIPING DATA

Maximum flow velocity in pressure pipes: __________ ft/sec

. Maximum flow velocity in gravity flow pipes: __________ ft/sec

. Number of possible pipe sizes:

. List of pipe sizes:

FORM IX

SPECIAL TREATMENT CHAIN COSTS

Treatment Chain Name	No. of Components* in Chain	Cost Coefficients					
		Capital			O&M		
		A	B	C	A	B	C

* Be sure to include cost coefficients for each element of the treatment chain For example, if two pretreatment units are combined in one chain, each must have its cost coefficient listed.

* All cost coefficients must be represented in January 1975 $.

FORM X

REGULAR TREATMENT CHAIN COSTS

Treatment Chain Name	No. of Components* in Chain	Cost Coefficients					
		Capital			O&M		
		A	B	C	A	B	C

* Be sure to include cost coefficients for each element of the treatment chains. For example, if three units are combined in one chain (i.e., secondary, filtration, and carbon adsorption), each must have its cost coefficient listed.

* All cost coefficients must be represented in January 1975 $.

FORM XI

CASCADE NETWORK DIAGRAM

Base :
Network No.

FORM XII

ACTIVITY PRETREATMENT

Activities	Pretreatment No. Network No.									
	1	2	3	4	5	6	7	8	9	10

FORM XIII

SPECIFIED REGULAR TREATMENT AT BTS'S

Network No.	BTS No.	Specified Removal Percentages Constituents										Regular Treatment Chain No.

FORM XIV

BTS MAKE-UP WATER TREATMENT

Network No.	BTS No.	Make-Up Treatment(1)	Network No.	BTS No.	Make-Up Treatment(1)

T - Make-up treated at BTS after blending with influent.
F - Untreated make-up blended with BTS effluent.

U.S. AIR FORCE

CASCADE WATER REUSE

COMPUTER

FORM

BOOKLET

GENERAL BASE DATA

NAME OF BASE

NUMBER OF CONTAMINANTS

NAMES OF CONTAMINANTS

NUMBER OF SOURCES

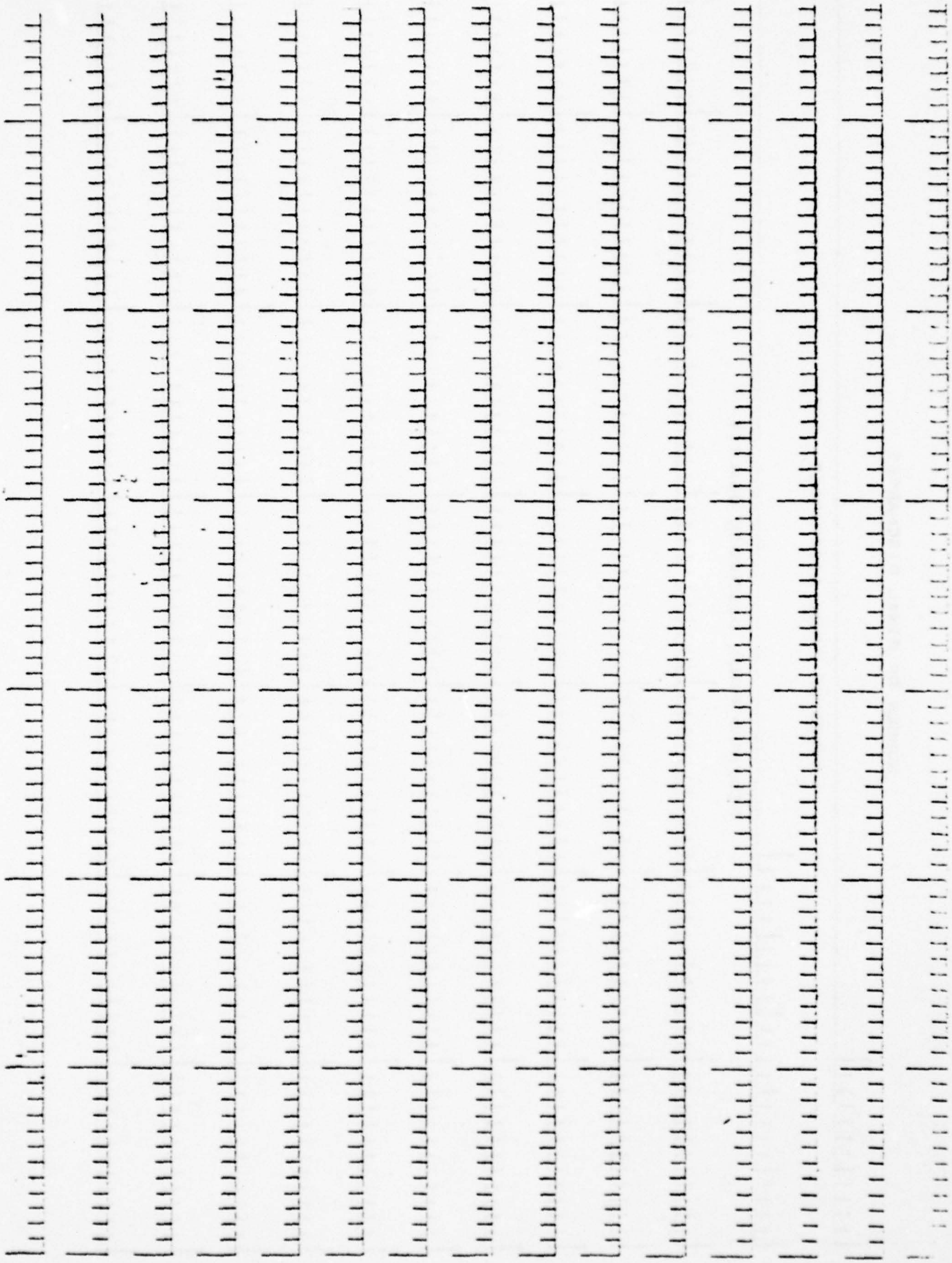
NAMES OF SOURCES

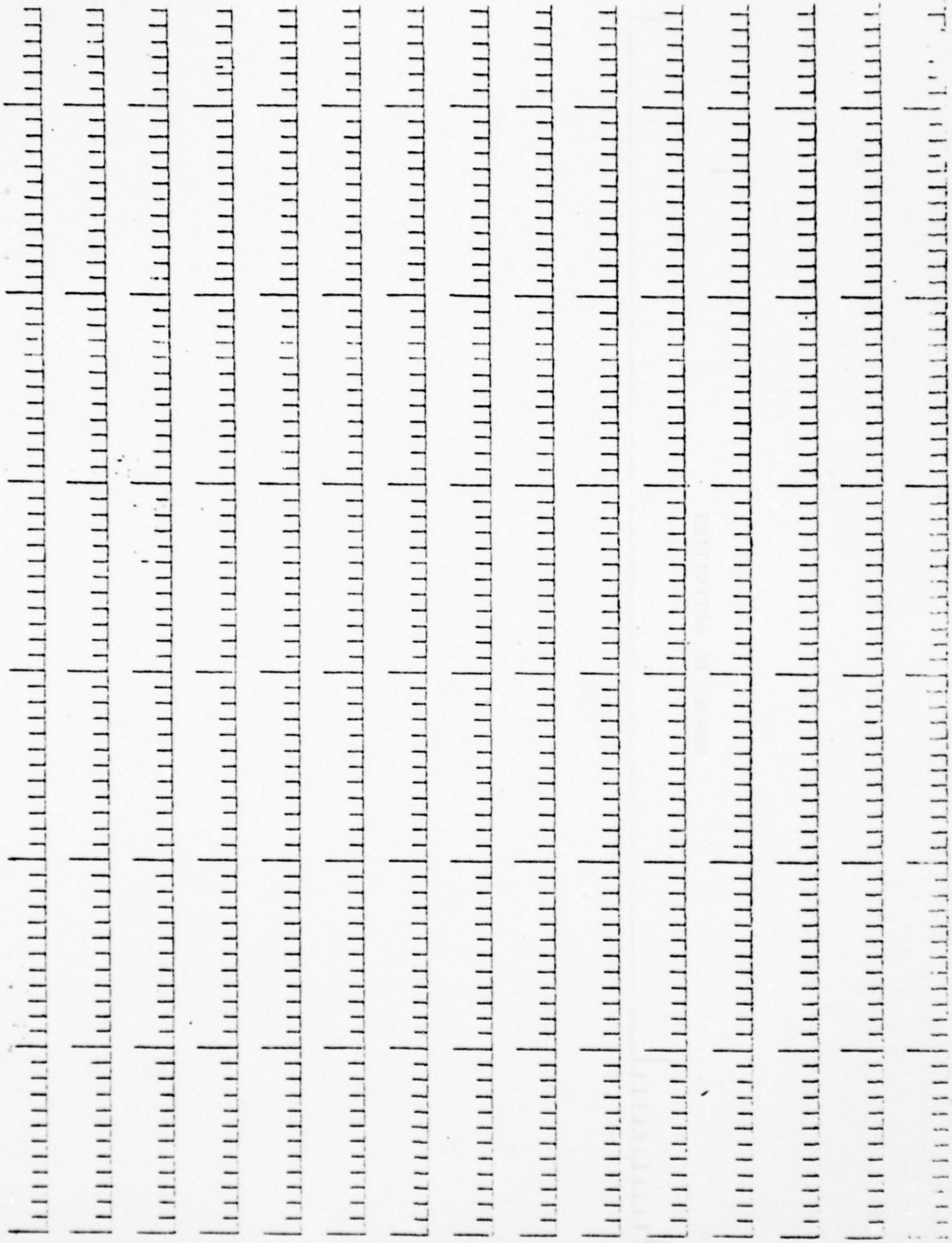
SOURCE WATER QUALITY
(mg/1)

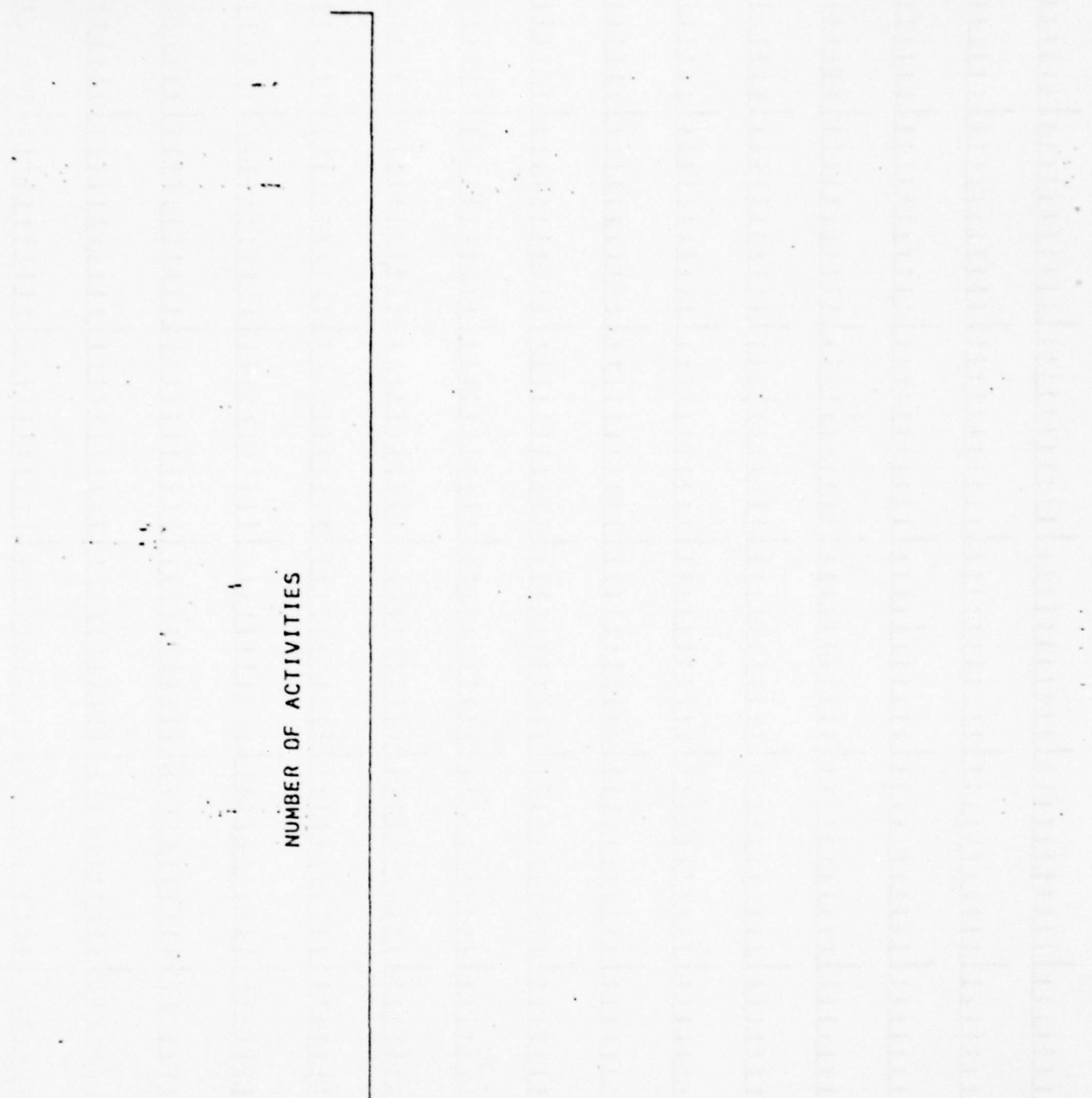
NUMBER OF FINAL DISCHARGES

NAMES OF FINAL DISCHARGES

REQUIRED FINAL DISCHARGE QUALITY






NUMBER OF ACTIVITIES

ACTIVITY DATA

ACTIVITY CODE AND NAME

(DAILY PROGRAM)

WATER IN

(GPH)

WASTEWATER OUT

(GPH)

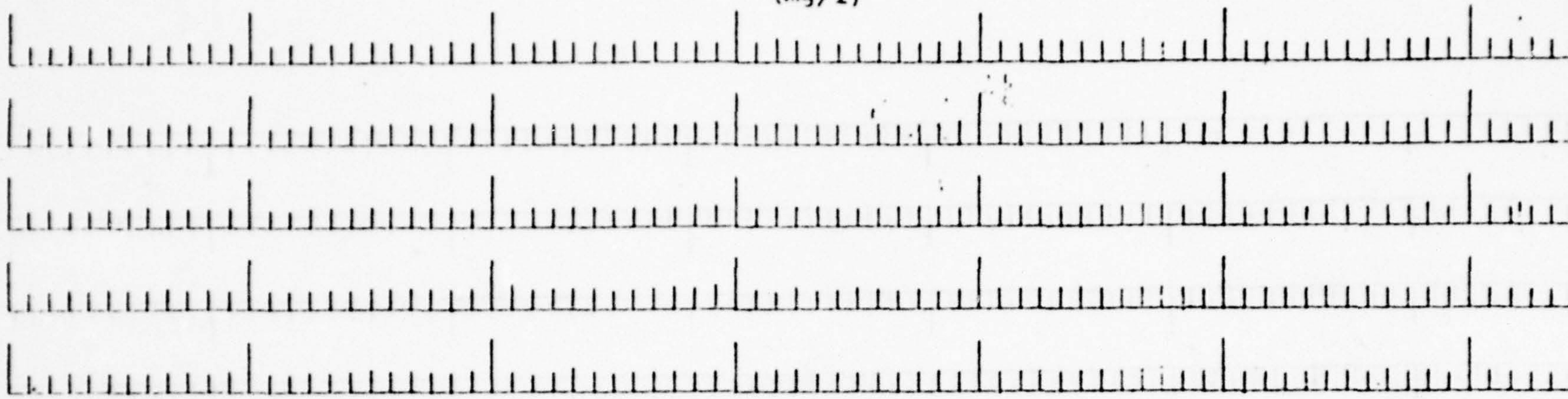
ACTIVITY DATA

ACTIVITY CODE AND NAME
(YEARLY PROGRAM)

WATER IN
(1,000 GAL/MO)

WASTEWATER OUT
(1,000 GAL/MO)

TOLERABLE CONTAMINANT LEVELS
(mg/1)

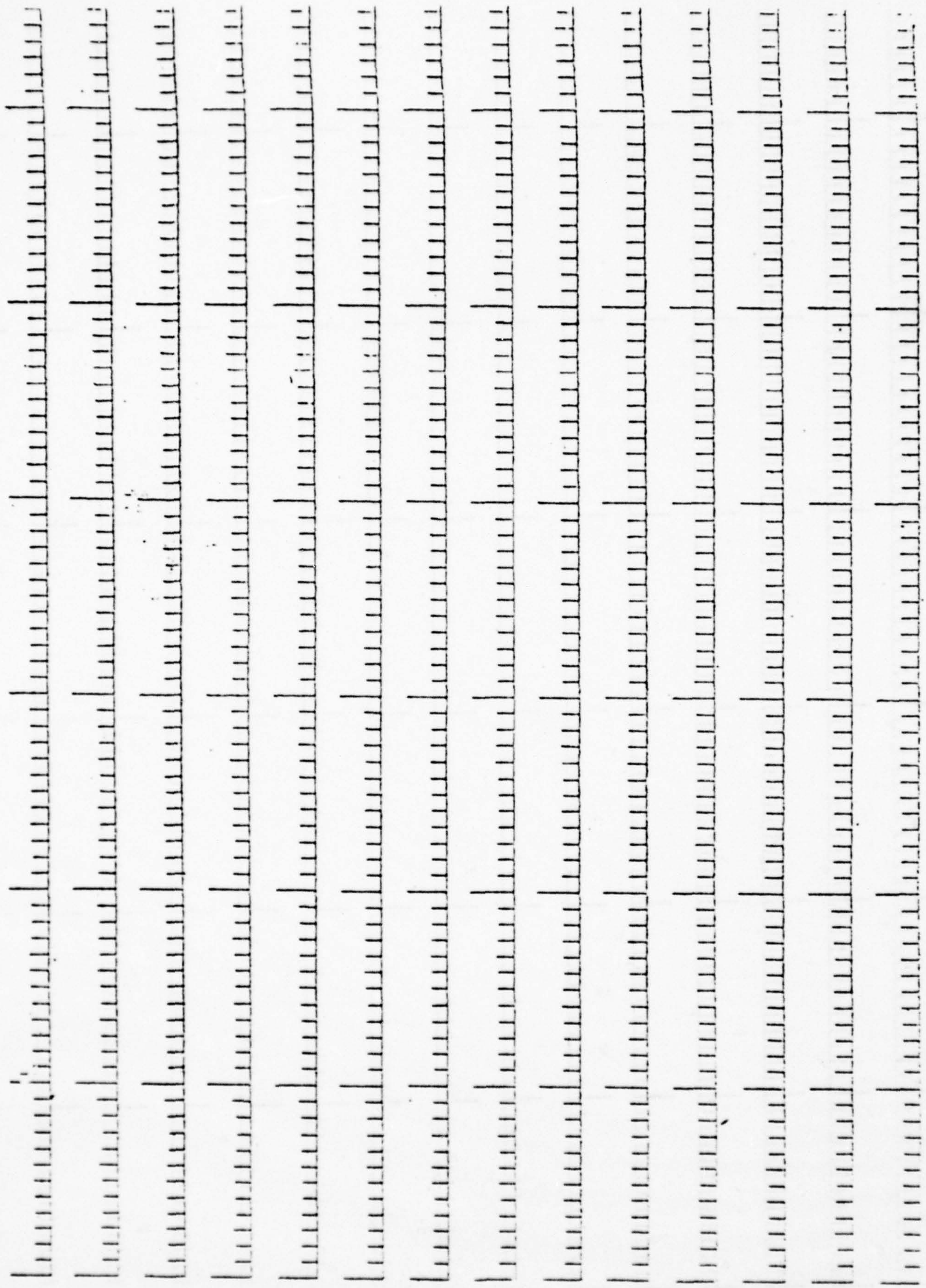


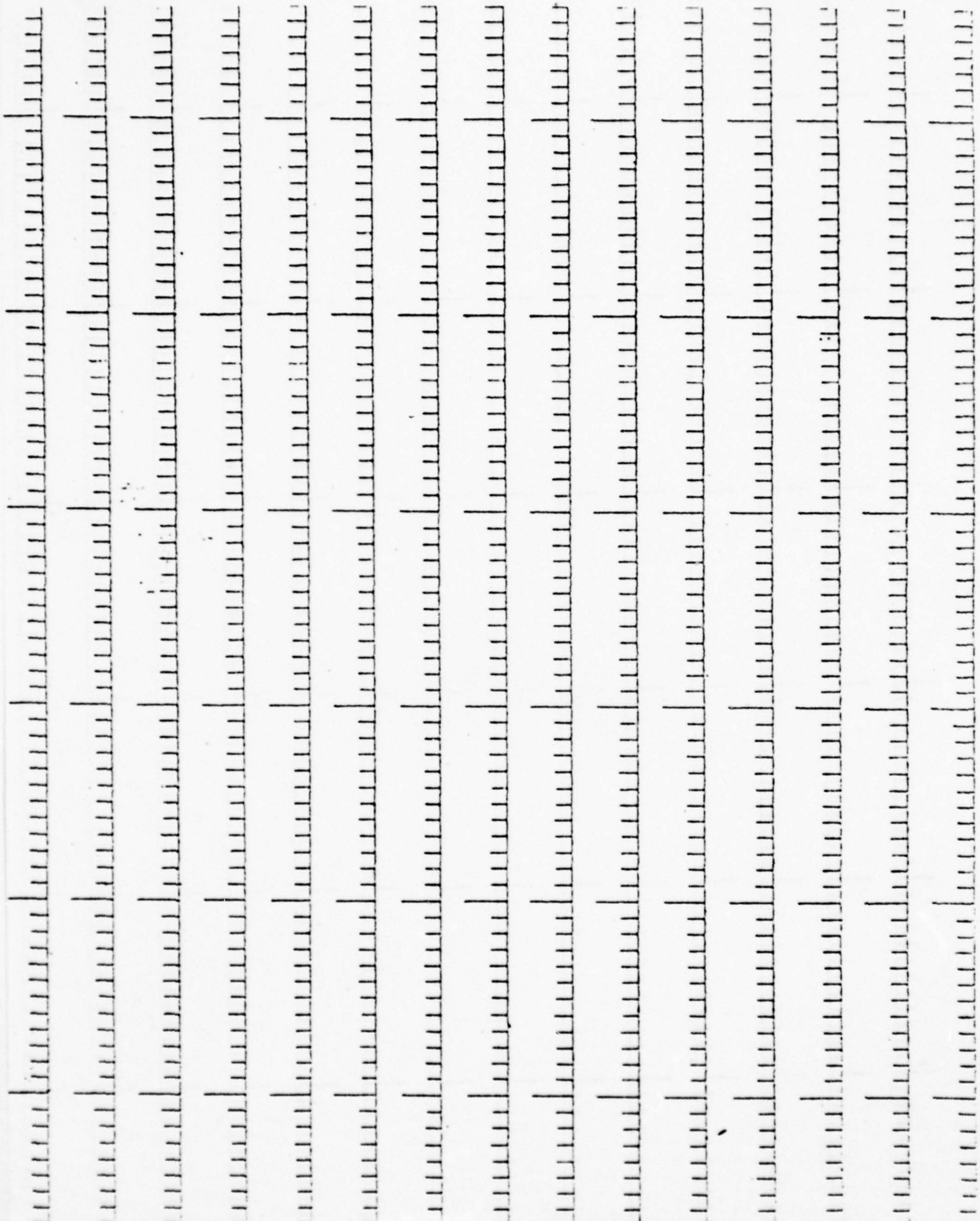
TREATMENT DATA

NUMBER OF REGULAR TREATMENT CHAINS

NAMES OF REGULAR TREATMENT CHAINS

REGULAR TREATMENT CHAIN REMOVAL PERCENTAGES

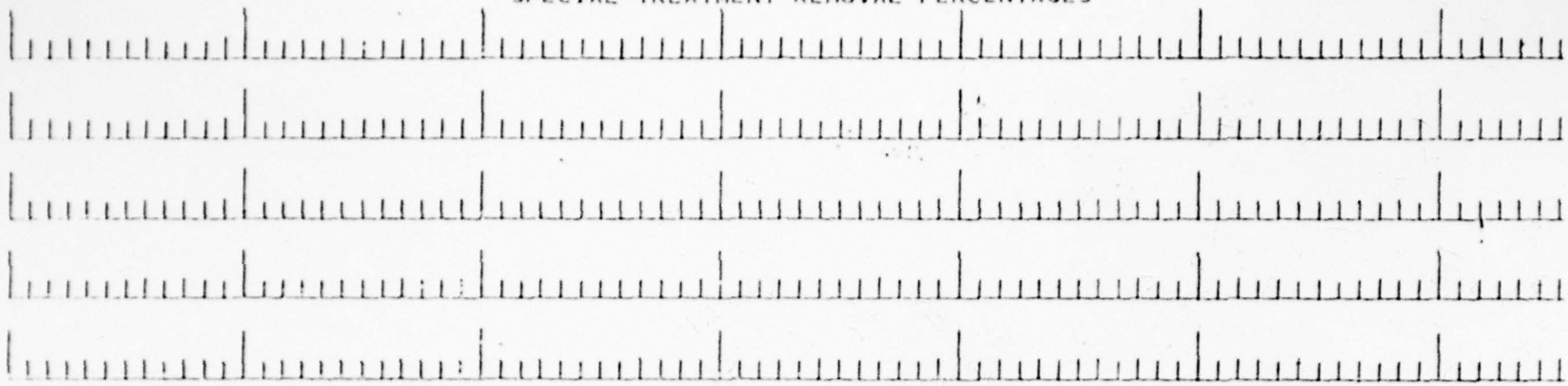




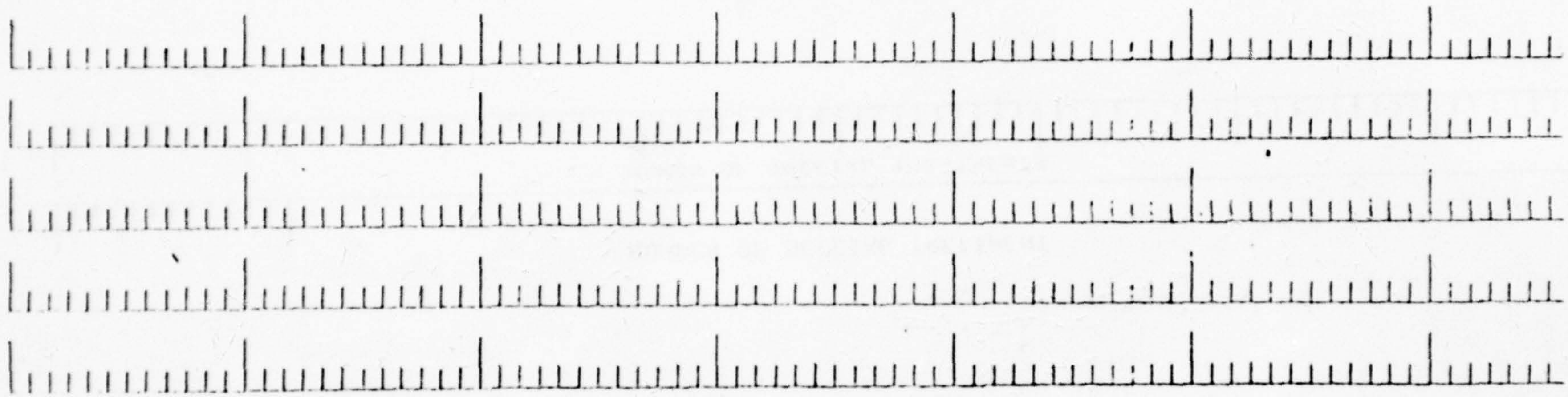
NUMBER OF SPECIAL TREATMENT

NAMES OF SPECIAL TREATMENTS

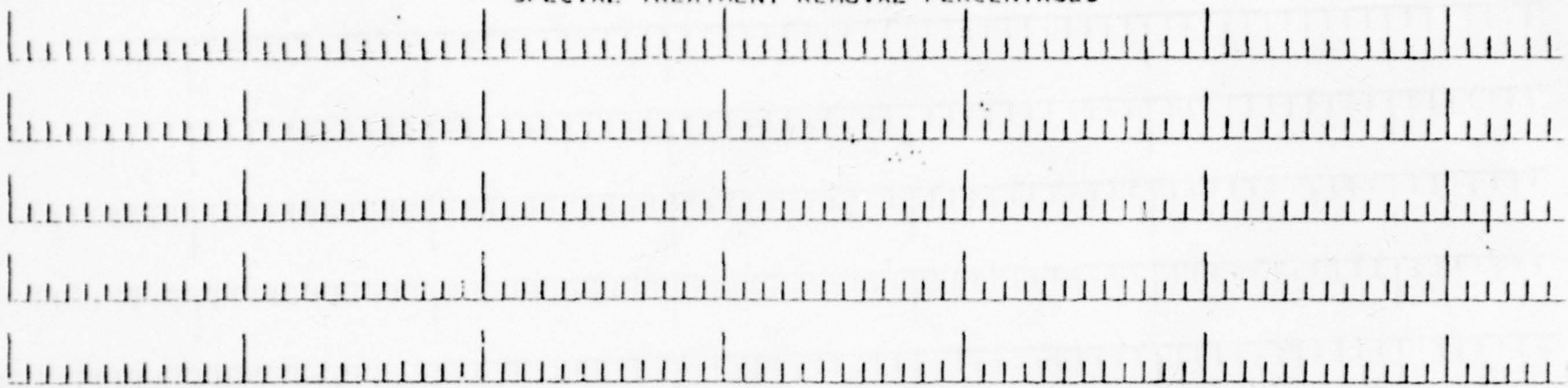
SPECIAL TREATMENT REMOVAL PERCENTAGES



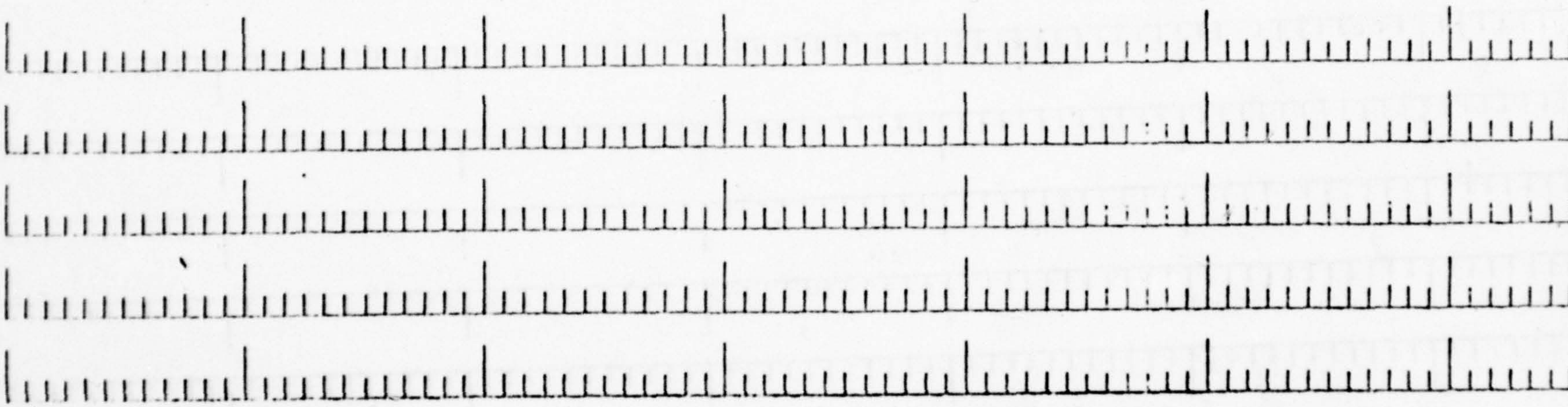
SPECIAL TREATMENT THRESHOLD CONCENTRATIONS



SPECIAL TREATMENT REMOVAL PERCENTAGES



SPECIAL TREATMENT THRESHOLD CONCENTRATIONS



SPECIAL TREATMENT REMOVAL PERCENTAGES

SPECIAL TREATMENT THRESHOLD CONCENTRATIONS

SPECIAL TREATMENT REMOVAL PERCENTAGES

SPECIAL TREATMENT THRESHOLD CONCENTRATIONS

SPECIAL TREATMENT REMOVAL PERCENTAGES

SPECIAL TREATMENT THRESHOLD CONCENTRATIONS

SPECIAL TREATMENT REMOVAL PERCENTAGES

SPECIAL TREATMENT THRESHOLD CONCENTRATIONS

COST DATA

% INTEREST CCI LCI LIFE (YEARS)

MAX. VELOCITY IN PIPES (FT/SEC)

NUMBER OF PIPE SIZES

PIPE SIZES

SPECIAL TREATMENT COSTS

NUMBER OF TERMS.

COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE

SPECIAL TREATMENT COSTS
NUMBER OF TERMS.

COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE

SPECIAL TREATMENT COSTS
NUMBER OF TERMS.

COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE

SPECIAL TREATMENT COSTS
NUMBER OF TERMS.

COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE

SPECIAL TREATMENT COSTS
NUMBER OF TERMS.

COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE

SPECIAL TREATMENT COSTS

NUMBER OF TERMS.

COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE

SPECIAL TREATMENT COSTS
NUMBER OF TERMS

COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE

REGULAR TREATMENT COSTS
NUMBER OF TERMS.

COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE

REGULAR TREATMENT COSTS
NUMBER OF TERMS.

COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE

REGULAR TREATMENT COSTS

NUMBER OF TERMS.

COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE

REGULAR TREATMENT COSTS

NUMBER OF TERMS.

COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE

REGULAR TREATMENT COSTS
NUMBER OF TERMS.

COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE

REGULAR TREATMENT COSTS

NUMBER OF TERMS.

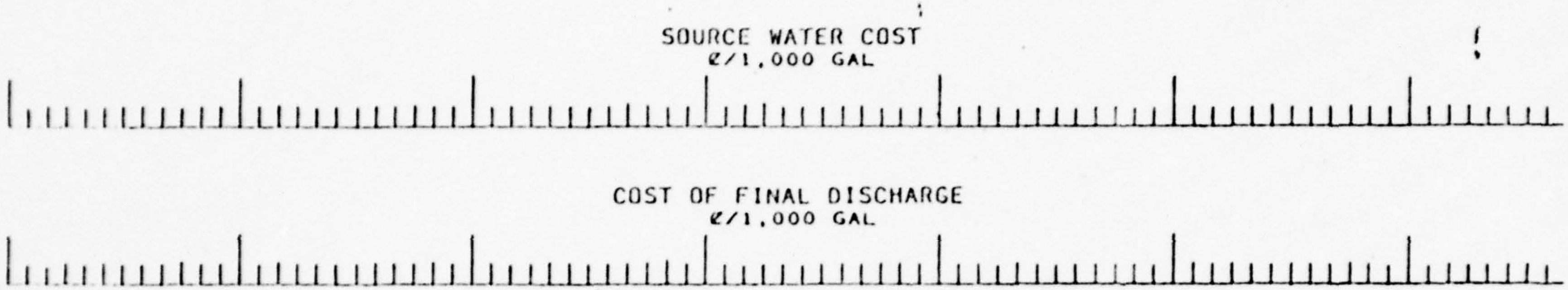
COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE

REGULAR TREATMENT COSTS
NUMBER OF TERMS

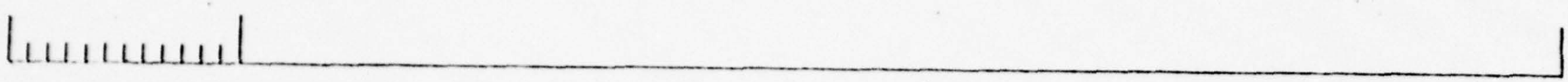
COST COEFFICIENTS

CAP. FIXED	CAP. UNIT	CAP. SCALE	O&M FIXED	O&M UNIT	O&M SCALE


SOURCE WATER COST
¢/1,000 GAL
COST OF FINAL DISCHARGE
¢/1,000 GAL

NETWORK SUMMARY

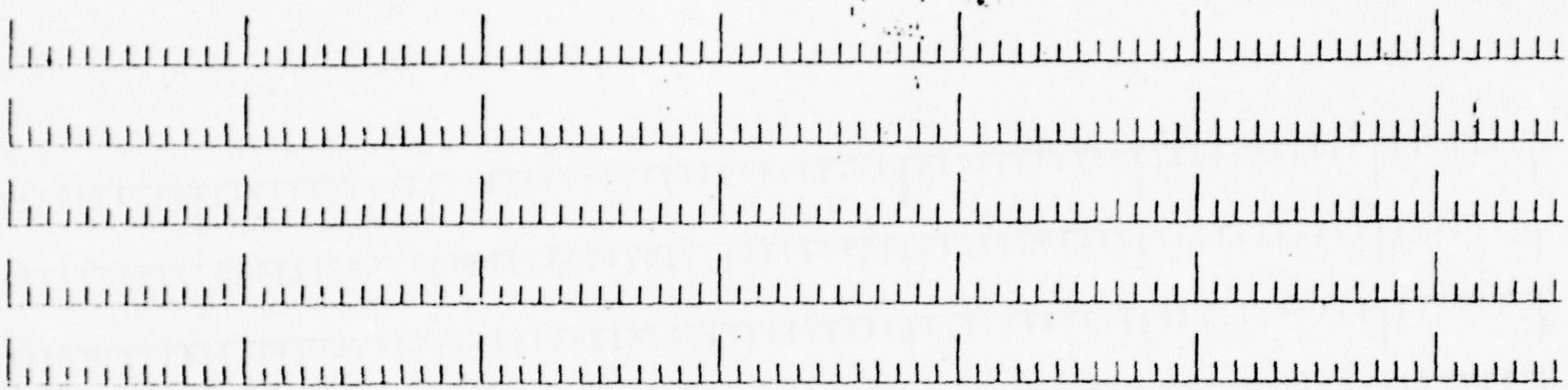
NUMBER OF BTS'S



#ACTIVITIES OUT	SOURCE #	DISCHARGE #	REGULAR TREATMENT	MAKE-UP TREATMENT	

ACT. OUT	BTS OUT	ACT. OUT	BTS OUT	ACT. OUT	BTS OUT

SPECIFIED BTS TREATMENT REMOVALS (OPTIONAL)



#ACTIVITIES OUT	SOURCE #	DISCHARGE #	REGULAR TREATMENT :	MAKE-UP TREATMENT :

ACT. OUT	BTS OUT	ACT. OUT	BTS OUT	ACT. OUT	BTS OUT

SPECIFIED BTS TREATMENT REMOVALS (OPTIONAL)

#ACTIVITIES OUT	SOURCE #	DISCHARGE #	REGULAR TREATMENT	MAKE-UP TREATMENT

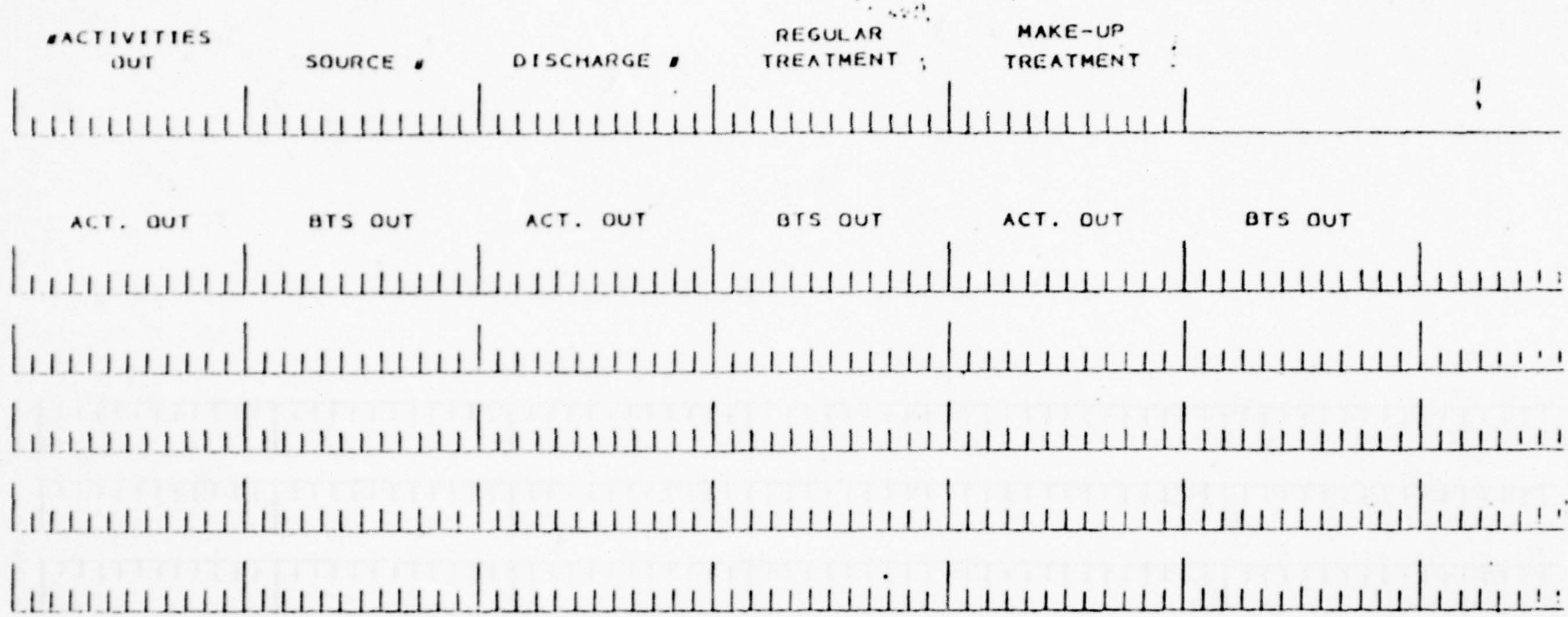
ACT. OUT	BTS OUT	ACT. OUT	BTS OUT	ACT. OUT	BTS OUT	

SPECIFIED DTS TREATMENT REMOVALS (OPTIONAL)

#ACTIVITIES OUT	SOURCE #	DISCHARGE #	REGULAR TREATMENT	MAKE-UP TREATMENT

ACT. OUT	BTS OUT	ACT. OUT	BTS OUT	ACT. OUT	BTS OUT

SPECIFIED BTS TREATMENT REMOVALS (OPTIONAL)


#ACTIVITIES OUT
SOURCE #
DISCHARGE #
REGULAR TREATMENT
MAKE-UP TREATMENT
ACT. OUT
BTS OUT
ACT. OUT
BTS OUT
ACT. OUT
BTS OUT

SPECIFIED BTS TREATMENT REMOVALS (OPTIONAL)

#ACTIVITIES OUT	SOURCE #	DISCHARGE #	REGULAR TREATMENT	MAKE-UP TREATMENT	
ACT. OUT	BTS OUT	ACT. OUT	BTS OUT	ACT. OUT	BTS OUT

SPECIFIED BTS TREATMENT REMOVALS (OPTIONAL)

#ACTIVITIES OUT	SOURCE #	DISCHARGE #	REGULAR TREATMENT	MAKE-UP TREATMENT

ACT. OUT	BTS OUT	ACT. OUT	BTS OUT	ACT. OUT	BTS OUT

SPECIFIED BTS TREATMENT REMOVALS (OPTIONAL)

#ACTIVITIES OUT	SOURCE #	DISCHARGE #	REGULAR TREATMENT	MAKE-UP TREATMENT

ACT. OUT	BTS OUT	ACT. OUT	BTS OUT	ACT. OUT	BTS OUT

SPECIFIED BTS TREATMENT REMOVALS (OPTIONAL)

#ACTIVITIES OUT	SOURCE #	DISCHARGE #	REGULAR TREATMENT :	MAKE-UP TREATMENT :	
ACT. OUT	BTS OUT	ACT. OUT	BTS OUT	ACT. OUT	BTS OUT

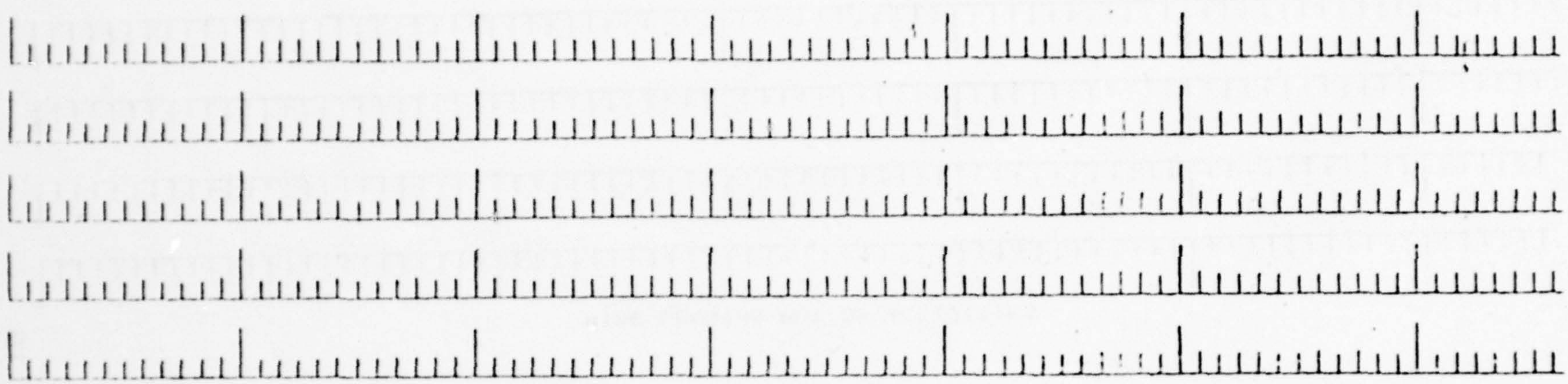
SPECIFIED BTS TREATMENT REMOVALS (OPTIONAL)

#ACTIVITIES OUT	SOURCE #	DISCHARGE #	REGULAR TREATMENT #	MAKE-UP TREATMENT #

ACT. OUT	BTS OUT	ACT. OUT	BTS OUT	ACT. OUT	BTS OUT

SPECIFIED BTS TREATMENT REMOVALS (OPTIONAL)

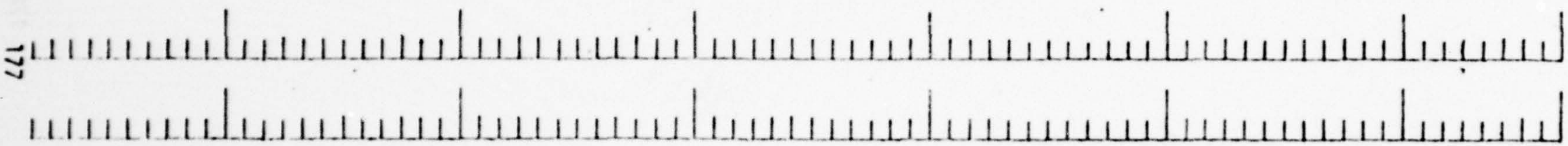
PRE-TREATMENT AT ACTIVITIES



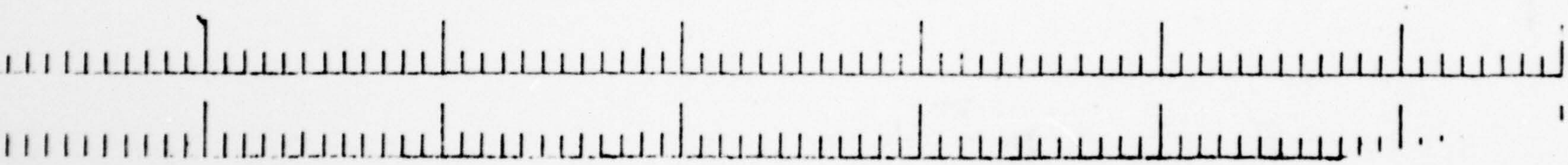
PIPE LENGTHS INTO ACTIVITIES

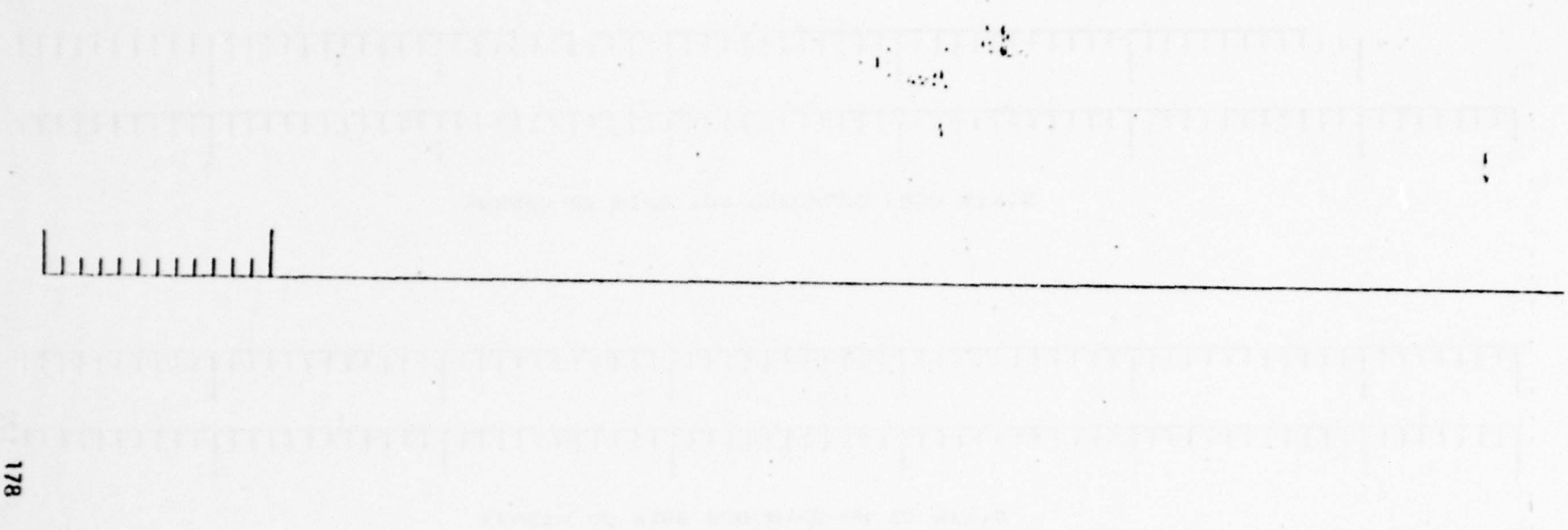
PIPE LENGTHS OUT OF ACTIVITIES

LENGTH OF PIPE FOR MAKE-UP. TO BTS'S



LENGTH OF PIPE FOR OVERFLOW FROM BTS'S





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